Telephony.
AN ILLUSTRATED MONTHLY TELEPHONE JOURNAL
VOL. V. CHICAGO, MARCH, 1903. No. 3.

THE EVOLUTION OF THE TELEPHONE SWITCHBOARD.*

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Two poets, as far apart chronologically as Lucretius and W. S. Gilbert, have sung the praises of the magnet; and the muse of Cowper has not disdained to celebrate such homespun and ordinary household gods as the sofa and the timepiece, and though the telephone switchboard is not a prominently manifested effect of a great force of nature, and not even a household god, it is in such close alliance with more than one of nature's forces, and stands in such faithful attendance to some of our home divinities, that it well merits more attention from the chronicler than it has thus far received.

The highly organized and highly specialized collocation of apparatus that we now term the telephone switchboard, and which is at present employed in the large central stations of our great city exchanges, such as the Cortlandt street central station in New York, and the main central station in Boston, as a means of carrying out the varied and complex functions required at the central station end of a great number of telephone circuits, has doubtless been seen by, and is familiar to many of you; while probably many more have a speaking acquaintance with it, and have considered it with more or less attention.

Its present condition of relative perfection and high efficiency has, however, been attained only after persistent effort, and after many previous attempts, each in its result showing some progress, but each indicating or developing faults and errors to be overcome by its successor.

At the outset of the telephone exchange business every telephone man had to learn his trade. Even the telephone itself was but two years old, and except Professor Bell and his immediate associates no one knew anything worth mentioning about that instrument or its capabilities. None certainly could foresee what direction the lines of improvement would take; and none could foreshadow the extent of growth which might be expected for such systems.

But notwithstanding the general ignorance, the telephone exchange came into existence; and with it necessarily came something for the convenient connection and disconnection of lines. It would be profitless to devote much time to the earliest switchboards of all. It is enough to say that during what I may call the dark ages of exchange telephony, the switching appliances were of three different types; and this largely because in the beginning there were three different classes of incipient telephone engineers. The electrical expert coming into the telephone exchange from the ordinary or regular telegraphic systems, naturally pinned his faith to the standard pin switchboard usually employed by the telegraph companies. Those coming from special systems, such as the stock quotation printing, burglar alarm and district messenger companies as a rule exhibited a preference for a switchboard whereon the lines had brass terminal plates with plug holes in them, the same to be united by switch-cords armed at both ends with plugs to be inserted in these holes. The telephone men with no previous telegraphic experience of any kind, chiefly those who had grown up around Prof. Bell, and under the influence of his immediate associates, were inclined to eclecticism as regards the rival claims to merit of pin and cord switchboards but believed in dividing the work of interconnecting and its suboperations between two or more operators, of whom one set received calls and made the required connections on the switchboard proper, while the others acting in some sort as dry nurses to the subscribers, supervised the communication, sent outgoing calls and encouraged the subscribers to talk.

As a means of receiving calls, some of the pioneer switchboards had a row of electric bells mounted along the top of the board, one for each line, and in such cases there was a normally connected battery, supplying current to a group of lines, the bells being operated by break keys at the substation. Still others had closed circuit annunciators, one for each line, these also being operated by breaking the circuit. Soon, however, the battery was discarded, being superseded by magneto generators at the substations, and then of course open circuit annunciators were substituted at the central stations. It is of interest to note that the battery, discarded twenty years ago as a cumbersome adjunct, is now one of the most cherished features of central station practice; and all through the history of telephone practice, thus it has proved, that appliances and methods discarded as being inferior at certain stages have been revived under the stimulus of more favorable conditions and advanced knowledge, and have turned out to be useful in the highest degree.

Before 1880 it had become decidedly manifest that some kind of telephone exchange service must be provided during the night. Few exchanges could afford to keep regular operators constantly at work later than ten o'clock. Consequently a compromise measure was resorted to, and a night operator was stationed in the central office with permission to sleep; and a night alarm consisting of a loud-sounding vibrating bell was provided, connected in a local circuit extending in one direction to a bar constituting a stop on

*A paper read at the 172d meeting of the American Institute of Electrical Engineers, held at New York, January 23, 1903.

which all annunciator drops might fall, and in the other direction to all of the several drops; so that the operation of any annunciator would ring the bell and awaken the operator. This contrivance is still employed in many small exchanges, and enables exchanges to remain operative at night, while as yet the number of subscribers is so small that a night attendant could not be otherwise afforded. Before this date it was also discovered that while the Western Union pin switchboard unmodified might be a satisfactory switchboard for telegraph offices, it was decidedly unsatisfactory for a telephone exchange. It was slow; it was not easily manipulated; it did not easily lend itself to co-operation with the other exchange apparatus; and it occupied considerable space. In brief, it had been devised for the needs of a telegraph office where a switchboard is but an incidental device arranged mainly to facilitate the connection of any particular line with any particular instrument or battery; and only on rare occasions to connect one line with another. In telephonic work, however, the function of the exchange is the interconnection of one line with another at all times and nothing else. To paraphrase the well-known couplet of Byron, the switchboard is in the telegraph office a thing apart; it is of the telephone exchange the whole existence.

Summarizing these considerations, it may be truly said that the main difference between the telephone exchange switchboard and that of the telegraph office, or any preceding system, was that whereas the manipulation of the telegraphic switchboard involves the employment of experts, the telephonic switchboard is so designed that it may readily be operated with great celerity by persons who are not only inexpert, but who actually are entirely ignorant of the nature of the operations which they continually perform.

In 1880 the most representative exchanges had switchboards employing long brass or painted connection strips extending from end to end of the board. In New York, as elsewhere, switchboards possessing this feature were employed, but there the preferred switchboard was operated by cordless plugs; the cross strips having a number of plug-holes, while a series of vertical conductors representing the subscribers' lines crossed these horizontal strips at a right angle in the rear of the board, these being spring plates overlapping the holes. Thus, when the plug was inserted in the hole of the cross-strip, it made a good rubbing connection with the spring line strip behind. The cross strips were arranged in pairs and were connected by looping wires to an adjacent table fitted with an operator's telephone and a call generator where connections were supervised, and any two lines concerned in a connection were attached by separate plugs to the two strips of a pair, respectively.

In other cities the long brass strips were employed without any vertical line strips, each line being represented by a single spring-jack only. When such was the case the connection could not be effected by simple plug connectors; but necessitated the employment of cords fitted at one end with flat wedges to enter the spring-jacks, and at the other with plugs to enter the holes in the crossing strips. In this case, also, the crossing strips were looped to tables where the connections were supervised by operators.

In these systems an incoming call announced itself by the fall of an annunciator. One of a number of switchmen (so-called) provided with a magneto telephone connected with a loop-plug adapted to fit the spring-jack of the calling line, would plug in and receive the order. The same switchman then united the calling line and the line wanted, to the two cross-strips of some particular pair; and thus connected them not only with one another, but also to the table of some particular operator. The operator notified of the connection thus made would first send a call current from a generator to the subscriber wanted, and receive his answer orally, and would then unite the two lines through a disconnecting drop. It was usually a matter of difficulty to get the two subscribers to talk with one another, and the operator had, as it were, to coax them along.

An early appearing difficulty with this class of switchboard was that the connecting strips running as they did from end to end of the switchboard took up an amount of space entirely disproportionate to their usefulness. Accordingly, they were later severed at one or more places, so that a number of connecting strips on the same horizontal plane might be severally connected to the same or different operators' tables.

Although the pin switchboard unmodified had not proved itself to be desirable, a new form of it was evolved during the year 1880, which considerably prolonged its lease of life. It was in desk form with a vertical part behind the desk, and in it the lines were represented by corrugated strips of brass mounted on edge, and crossed without touching, by a number of other corrugated brass strips also mounted on edge; the connections of any two line strips with any one or two cross strips being made by sheet brass connections plugs adapted for insertion at the intersections.

This switchboard was arranged in a number of groups, each to be presided over by a single operator, performing all of the several functions in the connection of lines; and several cross strips were assigned to her for local connections, while a certain number of others were extended to each of the other sections. An attempt about this time was made to classify lines by the trades, professions or vocations of the subscribers, but this failed by reason of the fact that it turned out that very few subscribers cared to communicate with others in the same business.

One horizontal strip of each group was connected with an earth branch including the telephones of the operator of such group, and another such strip was in like manner connected with the magneto generator of the same operator. Thus, by inserting a connection plug at the intersection of any line plate with the operator's telephone or generator cross strip, and performing any other requisite operation, the operator might converse with the subscriber, or send a call.

This switchboard was of low initial cost, and was, therefore, suited to the times, for it had already been discerned that the income of a telephone exchange was not by any means all profit. It was, however, mechanically and electrically bad. It occupied considerable space and the electrical connections made by its plugs were imperfect. There is, indeed, a legend that an electrical engineer was visiting a certain central station, where this switchboard was exhibited with pride, and asked whether the plugs made good connections. When assured that they did, it is said that he blew at the switchboard with the result that some forty or fifty of the plugs were blown out of place.

Meanwhile it had dawned upon a number of the telephone men of the day that the separate call generator at each switchboard adapted for manipulation by the operator, might be profitably superseded by a common generator supplying the entire central station, and having branches to each operator's position, and keys whereby the current might be transmitted over any line at will. This sometimes, and especially where power could not conveniently be applied, took the form of a calling battery supplemented by an automatic electro-magnetic pole-changer; but was preferably an alternating current magneto-electric generator, driven by any suitable power.

It will be seen that up to this time, indeed up to about 1884, there was no uniformity in switchboard apparatus; and there was no standard switchboard.

It had been ascertained by experience that the function of the central station was not merely to connect and disconnect telephone lines. It was far more complex. Calls were to be received, and signal receiving appliances therefore were to be provided. Calls were to be answered and

orders received, and for this purpose means were required to connect the operators' telephones with a call-originating line. Before connection could be established between a calling and a wanted line, it was essential to ascertain whether such wanted line might not be already engaged, and for this ready means of communication between the operators was necessary. If occupied, the fact had to be reported to the call originator. If not, a call signal had to be sent to the station wanted and thus means for sending signals was also essential; and finally some device had to be rearranged for the indication and reception of ring-off signals.

Most of these apliances had, of course, been associated in a kind of haphazard fashion with switchboards from the beginning; but not until about this time was any attempt made to incorporate them in the switch apparatus as a definite part thereof.

Upon the commercial introduction of the multiple switchboard, which, though invented as early as 1879, did not obtain general acceptance until about 1884 or 1885, it seemed that the time for organizing these several devices into a complete and self-contained machine had arrived.

The thought underlying this type of apparatus is that the entire switchboard shall be divided into sections of suitable magnitude, and that each telephone line entering the station shall pass to every section and be furnished at each with a switch socket, so that at each section any two of the entire number of lines may be united for through communication. As practically worked out, the call receiving indicators of the whole number of lines were divided between the sections; and thus it came about that the call of a subscriber is always answered at some one section, and that switch connections in response to such call and between the calling and the wanted line are always made at the section where the call has come in and been answered.

There is no truth, however, better established than this: that each radical advance in electrical apparatus involves and paves the way for a number of subsidiary devices. And so it was here. The very fact that all of the incoming substation lines were represented by switch-sockets, and were accessible at each of a plurality of switchboards or switchboard sections, rendered further invention imperative. It became absolutely necessary to provide some means whereby the operator at any one of the sections could quickly find out for herself whether a line called for was or was not "busy." Accordingly, such means were devised. Without a "busy test" the multiple switchboard would be little better than a theory. Provided with a busy test system it becomes the practical basis of continued subsequent improvement.

Nearly all practical "busy test" arrangements provide that the insertion of a switch-plug into any one of the switch-sockets of any line at any switchboard shall bring about some electrical change which can be tested for, and detected at all of the other switch-sockets of the same line. If found to be present, the operator infers that such line is busy, but if when tested for such change be not manifested, the line is free and may be switched.

Scores of "busy test" arrangements have been proposed; but few are really practical. In that which was associated with the earlier multiple switchboards, the socket-frames of every line were represented on the face of the board by a metal ring surrounding the plug-hole; and all the metal rings of all of the sockets of each line were permanently united to one another by a wire running along at the back. The shank of the switch-plug was also wholly of metal, and when inserted in the socket of any line at any board it acted to establish a conductive connection between the telephone line proper and the conductor uniting the metal rings, thus grounding the latter, since the telephone line was grounded at the sub-station. A small battery was included in circuit with the operator's telephone at each section-operator's position, and keys were provided whereby the telephone might be looped into any one of the switch-cords, a number of which were placed at each position. Thus, to test at any section for the ground, cross, or other abnormal condition, which would indicate that a wanted line was engaged at some other section, it was merely necessary to touch the tip of the switch-plug to the metal ring (hence termed the "test ring") of the socket, which at such section represented the line called for. Should the wanted line be busy, a portion of the current of the small battery would pass by way of the test ring and the tip of the plug through the operator's receiver and produce a clicking sound therein; but if the

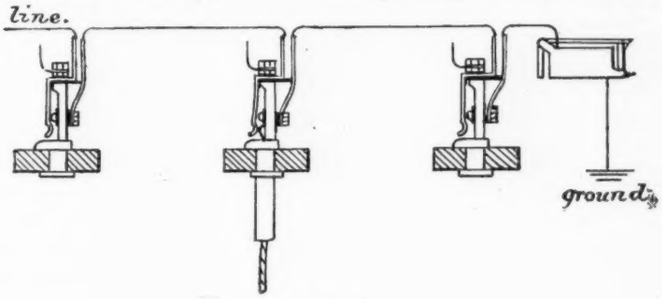


FIG. 1.

line when thus tried were disengaged, no such sound would be heard. In the multiple switchboard of that period, the jacks or sockets of the lines at each section were arranged in panels over the front of the board; the call devices were annunciators arranged in banks below these panels; the switch-cords with plugs at each end hung from a kind of gallows frame above; and on a keyboard in front of the operator were keys associated with the several switch-cords respectively, for directing the call current over any line switched to any particular cord, and for similarly connecting the operator's telephones in the circuit of any cord to answer calls, and to talk with either subscriber. The disconnecting annunciators, one for each switchboard, were mounted on a single row at each section. The circuits were of the single wire type with earth return; the switch-sockets of the several lines—one for each line at each section—each had a spring and point contact, and these contacts, as indicated in Fig. 1, were all in series in the line.

As arranged for the switchboard of that period, the operators' telephones common to all cords of the section, were connected in an earth branch of the cord conductor; and

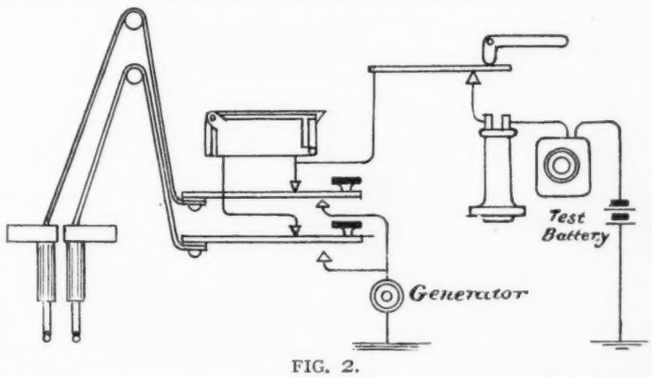


FIG. 2.

the disconnecting annunciators, one for each switch-cord, were each connected directly in the circuit of its own cord. Fig. 2 indicates this arrangement.

Switchboards of this general type were installed for several years—the first one employed in New York being placed in a central office in John street—and in general were clear improvements over everything preceding them; and among other features of advantage they greatly increased celerity in operation.

The disclosure, under operative conditions, of faults,

weaknesses and opportunities for improvement, was, however, inevitable, where the engineers of both manufacturer and user were constantly on the watch. It was very soon observed that the manipulation of switch-cords hanging from a point above, was a strain upon the operators, besides being in other respects inconvenient; and soon their position was changed, and the plugs were made to rest with the calling and listening keys on the keyboard, the cords hanging below with a weight for each, to keep it taut, and for its automatic retraction. Then it was noted that the speed of operation was restricted because on the receipt of a call signal, the jack of the line, the call of which was to be answered, had to be found in the panel where it and adjacent numbers were placed and to the avoidance of this defect, the next improvement was directed. There was provided for each line at the section where its calls were answered, an additional switch-socket to be used for the answering plug of a pair, and in responding to calls only. This was termed the "answering jack," and was placed close to the call signal of its own line. Switch connections were greatly facilitated by this expedient because whenever a call was received the operator was not requird to take thought, but might at once plug into the answering jack which was close by.

After some four or five years' use of grounded circuit

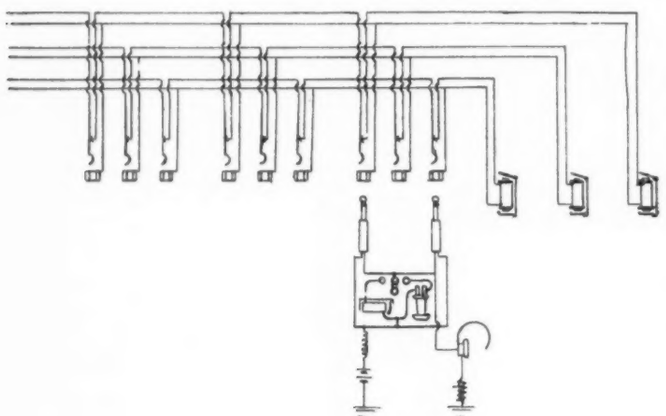


FIG. 3.

multiple switchboards it became evident that the time for the inductively neutral metallic circuit had arrived. One multiple board, the largest thus far constructed, had been set up and wired for grounded circuits; but so clearly was it seen that to proceed further in that direction would be a mistake, that this board was not put into operation until it had been compeltely re-wired for metallic circuits. This advance was a radical one, and followed the introduction of underground wires, almost as a matter of course. The series mode of arranging the spring-jack contacts was at this time retained, these being in one conductor, while the other main conductor was connected by parallel branches to the test rings of the circuit at the several sections respectively.

In this arrangement which is shown in Fig. 3, the call annunciator was connected on the answering-jack section between the two main conductors, the normal circuit through it being opened by the separation of the jack contacts when the switch-plug was inserted. This step in the onward progress of the switchboard carried one or two auxiliary improvements in its train. The operators' telephones and clearing out annunciators were no longer connected alternatively in series in the cord conductors, but after a few tentative arrangements were bridged between the cord strands, controlled, however, as before, by their several keys; but when thus placed, it became necessary to wind the disconnecting annunciator with many turns, and thereby give it a high resistance and impedance; as otherwise the voice currents from either of two circuits switched together, tended to be shunted through the bridged signal device.

The switchboard had now become a really good and homogeneous machine, well adapted to satisfy the conditions and requirements of its own day; and here for a while its development seemed to be stayed. Yet it was soon seen that there was abundant scope for further advance. New switchboards became old, and old ones older. Others though still new were employed in the soft-coal consuming cities of the middle west. In all of these cases, and more particularly in those last-named, the series-connected jacks developed high-contact resistance which materially weakened the loudness and clearness of conversation transmitted through the circuits concerned; and as the number of lines connected increased with marvelous rapidity, it was found that the switch-sockets occupied too much space on the face of the board, so that a considerable reduction in size soon became imperative, in order that the requisite number of switch-sockets might be crowded, without detriment to operative efficiency, into a given space.

The subsequent development of the telephone switchboard depended upon the outcome of three apparently parallel and independent but really co-ordinate and gradually convergent lines of investigation, which were all about this time under consideration.

These investigations were directed towards:

(*a*) The further improvement of the switchboard apparatus proper, by abolishing the serially-connected jack contacts, which as indicated, were a prolific cause of imperfect service; and by substituting some form of construction wherein each subscriber's line, when switched to another, would have a clear, continuous and highly conductive path through the switchboard for the voice currents; together with such other changes as each progressive advance might render necessary.

(*b*) To do away, if possible, with the multitudinous transmitter batteries of the sub-station and operating room, and to substitute for them a common central source of transmitter current; for if this could be done, there would not only be effected a great reduction in the number of calls required, but such as were required might be kept at all times under the eye of skilled employes.

(*c*) To arrange if possible for the gradual displacement of the sub-station call generator, and the necessity for its operation in the transmission of incoming call signals; to provide that call and disconnect signals should be automatically transmitted by the simple acts of taking the receiver from the hook switch, and restoring it thereto; and to devise suitable appliances at the central station for the appropriate display of these signals.

These several directions of prospective advance seem superficially to have little necessary community with each other, but the closer they are viewed, the more apparent will it appear that the realization of all would inevitably involve the complete re-organization of the switchboard; and that the efforts thus far devoted to the subject must be regarded henceforth as having resulted mainly in the determination of the principles which should be followed; and of what features were and were not desirable in an ideal switchboard. This was a well advanced position; and constituted a definitive foundation on which the completely organized superstructure of an efficient modern switchboard might be successfully reared.

Considering first the direct improvement of the switchboard as a means for the rapid interconnection and satisfactory through operation of lines, it is sufficient to say with respect to the diminution in the size of the parts, that experience and practice had by this time enabled manufacturers to make spring-jack and other mechanism very small. The main problem was clearly the elimination of the spring-jack contacts. But how? Naturally, by arranging the

switch-socket contact members at each section in parallel branches from both of the main conductors of their respective lines. But here was a difficulty: the serial spring-jack contacts were not by any means purposeless. The manifestation of incoming calls involved a subscriber's circuit, closed at the central office end, and an annunciator or similar call device connected in it; and the main purpose of the separable contacts in each jack was to ensure that while the spring member of such contacts which was on the lineward side should engage the inserted plug, the same should also be lifted by the plug tip from the fixed or insulated pin contact, thus opening the circuit at that particular socket, and cutting off all that portion of the circuit inwardly; that is to say, the original terminal including all following switch-sockets, together with the annunciator. Herein lay the difficulty; for if the insertion of the plug merely made contact with two branch springs, and did not sever the main conductors, how should the original terminal and annunciator be cut off?

It is of interest to note that the connection of multiple board jacks in parallel was not at this time a new idea. Indeed, the multiple board as first devised was on this plan; but as then suggested, the difficulty outlined did not occur, since the board in question was intended for use in association with circuits over which incoming calls were not sent (there being a special call circuit), which circuit therefore did not have a central station annunciator, and might be, and were left normally open.

Every telephone engineer had known almost from the inception of the art, that electro-magnets indiscriminately placed in series in a telephone circuit strongly opposed the passage of the rapidly changing voice currents, making reproduction of speech weak and indistinct; and by this time Oliver Heaviside had coined the word "impedance."

But if we take electro-magnets out of the main conductors, they will of course no longer oppose the passage of the voice currents in their legitimate circuit, and if we then connect the magnets in bridge between the mains, we no longer need to disconnect them when we unite one line with another, because they still retain the impedance, which can be increased to any desirable extent, and because we can then make that impedance useful to prevent wastage of the voice currents through the bridges thus constituted. The disconnecting annunciator had, in fact, as we have already seen, been so connected; and on party lines there were many high impedance "bridging bells," so-called, also in parallel between the mains; which were employed without bringing about any perceptible depreciation of the transmitted speech. So then the first solution came to several minds at once. Why disconnect the calling annunciator at all? Why not disregard it, and leave it connected with the line while the circuit is switched, depending upon its impedance to prevent the short-circuiting of the currents through the annunciator branches thus left intact? This was done, but it became necessary, as in the prior case of the disconnecting annunciator, to wind the magnets with many turns, and generally to make them of high impedance. There was, however, nothing objectionable in so constructing them, because the higher the impedance, the less chance there was for the voice currents to be shunted that way.

Fig. 4 shows in diagram the talking circuit as thus formed between two sub-stations; the circuits of such substations being switched together under these conditions. In this figure L and L^2 represent circuits extending from substations S and S^2 respectively, to a central station C, and there provided with permanently connected call annunciators A and A^2. They are supposed to be united for conversation by the switch-cord conductors *c*, between which the disconnecting annunciator *d* is bridged. So connected, the line annunciators are obviously bridged also, and thus the through circuit has at the central station three bridges, each containing an electro-magnet. Here, then, arises another difficulty. The wanted station must be called by the central station operator after the switch-plug is inserted in the proper line jack; and since the annunciator of the wanted line is not cut off, it will respond unless means are taken to prevent. Moreover, since it may be and probably

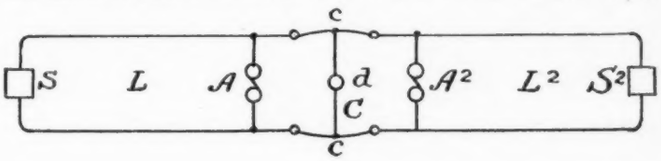


FIG. 4.

is at another section of the board, its operation will doubtless be regarded as a call by the operator there, who of course will try to answer the supposed call. Again, when the conversation is over, and the sub-stations S and S^2 ring off, the line annunciators A and A^2 are again likely to respond, one of them in any event being probably at another section of the board, so that this also will be taken as an incoming call. A number of propositions looking to the avoidance of such false signals were proposed, but the most promising plan for the latter contingency was so to arrange the switch-plugs and sockets, that the insertion of the plug might close a local circuit containing an electro-magnet, which magnet would when excited by the closure of its circuit act to hold the armature of the annunciator in its normal position so that the annunciator could not operate and display its signal, even though a current should pass through its actuating magnet. This device, which is indicated by Fig. 5, worked in fact so satisfactorily that it not only prevented the undesired operation of the annunciator, but also acted to re-set the same, when the signal had been given, pursuant to an original call; so that a drop fallen to display such signal did not need to be manually replaced, but was automatically restored as soon as a plug was inserted to answer the call.

In sending outgoing calls over the wanted line, a satisfactory expedient to prevent the operation of the annunciator of the line wanted, was so to connect the actuating and retaining magnets, that while incoming call currents

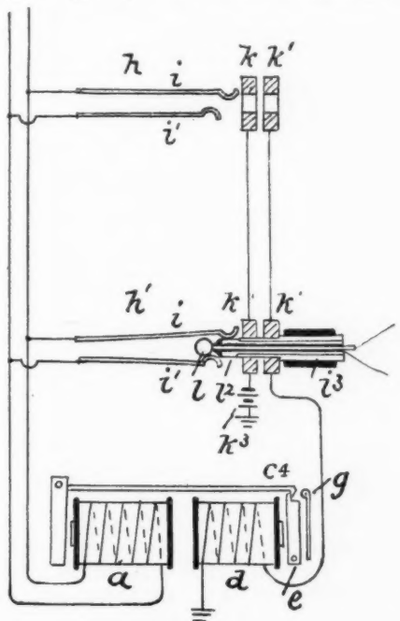


FIG. 5.

passed through the actuating magnet only, outgoing call currents were passed through both actuating and retaining magnets.

So many adverse electrical influences were now abroad,

by reason of the numerous heavy current systems which had been installed, that the "busy test" arrangement already described was no longer serviceable. Charges and stray currents on the line due to such influences tended to produce false busy signals. Accordingly, a form of "busy test" circuit never crossed or conductively associated with the line conductors, but altogether local was substituted. The insertion of the plug for the purpose of switching one line to another, was made to close one of two gaps in the local test circuit which was in part formed of the several test-rings of each line and the conductor uniting them; and also acted to connect a battery thereto, thus raising the potential of all the test rings of the line at all sections. The other pole of the battery was connected through the operator's telephone to the tips of all the calling or companion plugs. Thus, when the tip of such a second plug was applied at any section to the test ring of the wanted line, the occurrence or non-occurrence of a click in the instrument, enabled one to readily infer the engaged or disengaged condition of the said wanted line. As thus modified, a number of switchboards were installed, and the type of apparatus became known as the "branch terminal" switchboard. The talking currents, had through this board a clear conductive path not liable to be impaired by the presence of jack contacts or other abnormal resistance; and in fact without any contacts other than those made at the actual switching points. Thus far, then, a desirable advance had been attained, and the branch terminal or parallel connection switch-socket arrangement has remained in use until the present time.

The branch terminal switchboard at first brought commercially to the front, did not provide for the other two desiderata which have been indicated. Yet these were not very far behind. It was more important to provide a central source for sub-station transmitter supply common to all or a great number of lines, than it was to provide a similar arrangement for calls and other signals. But it seemed likely that if either could be practically arranged, the other might also be provided for by some modification of or addition to the same means; and in the end, thus it has turned out.

After much consideration and trials, both experimental and commercial, of many plans, the "how" of an efficient central and common battery system for telephone circuits, and the central and sub-station transmitters, together with a system of incoming call signals and supervisory signals was as a whole devised, and decided upon. In it, the same central office source of current may be employed for both signals and transmitters. The branch terminal mode of switch-socket connection was retained, each socket being composed of a frame-piece with a test ring in front, and two or more internal contact springs. At each section are the call devices, and the answering jack for the lines which are to be answered there, and a switch-socket for all lines entering the office; there being also a sufficiency of switch-cords, each with a switch-plug at each end.

The sub-station circuits were then arranged to be, while at rest, conductively closed at the central station through a battery and call device, and conductively open at the sub-station but it was necessary to provide some kind of an operative circuit for the polarized sub-station bell, as otherwise calls from the central station could not be received; and the plan which seemed most promising, and which has been generally adopted, is to place a condenser between the severed ends of the two line conductors and in series with the bell magnet. By this expedient while the circuit is open at the sub-station for a steady current, it is practically closed for the passage of the alternating ringing currents of the central station generator, to which the bell is adopted to respond. There is also the ordinary hook-switch which serves as a support for the receiving telephone when not being used; and as long as the receiver remains in place on the hook, the foregoing conditions continue; but as soon as the receiver is lifted from the hook, the metallic circuit is closed through the sub-station telephones and the current of the central battery being thus enabled to flow, causes the operation at the central station of the call signal relay.

A small glow lamp serves as the line or call signal, possessing the great merit of being prompt and self-acting both in display and withdrawal; and in practice is placed in a short local circuit controlled by the call signal relay, which has its magnet connected in the main line, and is responsive to the initial operation of the sub-station hook-switch.

Fig. 6 indicates the arrangement, which as regards the initial call signal was now complete; and also illustrates the devices now to be described.

The constantly connected annunciators of the branch terminal board were thus superseded by a relay and a lamp,

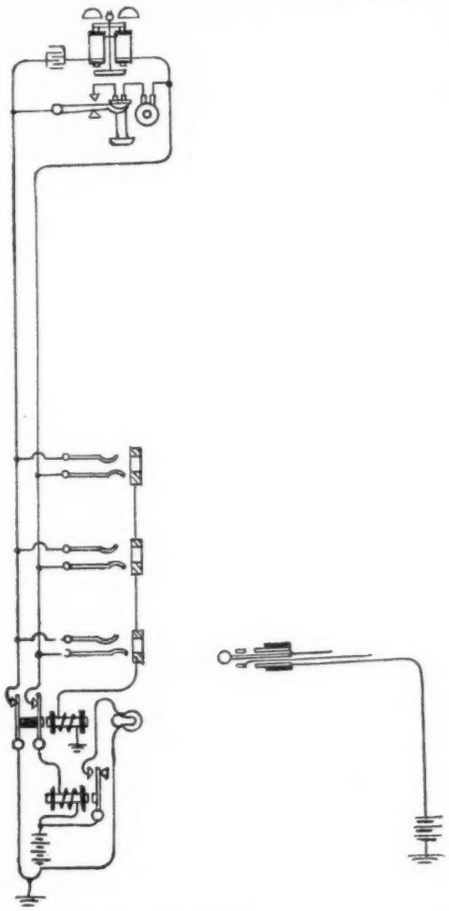


FIG. 6.

and the appliances formerly employed to maintain the quiescence of such annunciator were now made, instead, to operate a cut-off relay by means of which the lamp-operating relay might be cut away or disconnected, and the lamp signal thereby withdrawn, as soon as the call was answered by inserting the switch-plug. This cut-off relay has two resting contacts through which the two conductors of the main circuit respectively pass, in such manner that on the excitement of the relay and the consequent attraction of its armatures, the contacts are parted and the continuation of the line, including the call relay and the normal battery connection, is cut off. The cut-off relay itself is in a local switchboard circuit controlled by, and leading through contact pieces of the switch-plug and socket. The switch-socket for this purpose has interior contact springs for both main conductors, thus leaving its frame-piece or test-ring at liberty for the local circuit; and the several test rings of each

line are united by a fixed conductor extending from all of them to one terminal of the cut-off relay. The plug also has three insulated contact pieces adapted to register with the two line springs and the test ring of the socket; the cord conductor extending between each pair of plugs comprising two main line strands which extend from plug to plug, and a local circuit strand for each plug. A battery has one of its poles connected with the plug local circuit conductor and the other to the remaining relay terminal, so that when the plug is placed in the socket of any line, the cut-off relay circuit is closed, and the relay operates to disconnect the line terminal and relay. At the same time the potential of all of the united test rings of the line thus switched is raised to furnish appropriate conditions for the "busy test."

But this is not all. Supervisory signals are regarded as being necessary. These, also, are lamps, and two such are provided for each switchcord, and associated with the two plugs respectively, being placed in the cord section of the local or cut-off relay circuit. Thus placed, they are, of course, non-operative except when the plug is in its socket; but the plug being thus inserted, their function is to afford an indication to the operator of the condition of things at the sub-station. They can only be displayed when the hook-switch at the sub-station is in its lower or normal position; that is to say, the position in which it is maintained while the receiver hangs on the hook. When in answer to a call the operator inserts the answering plug in the socket of a given line, the associated lamp does not light, because the sub-station receiver has already been taken from the switch to give the order. But when the companion plug is placed in the socket of the wanted line, the lamp signal of that plug does light, because the receiver at the wanted sub-station is not removed from the hook; it thus follows that when this receiver is taken up in response to the call, the light is at once withdrawn. Again, when the conversation is over, the replacement of either or both sub-station receivers will once more illuminate the corresponding lamps to serve as a disconnecting signal. Or if either party desire at once a connection with some other line, the lamps may be made to flash several times in succession, by oscillating the hook switch. It must be apparent that such a system of supervisory signals is both ingenious and scientific. Its essential and underlying principle is that the supervisory signal of each plug is controlled in part by the plug and socket switch contacts of the local circuit wherein it is connected, and in part by the hook switch at the sub-station of the line to which the switch-socket belongs; and further, that the working of the signals is dependent in the first instance upon which of these two switch devices was first operated. Thus, in the case of a call being answered by the insertion of the switch-plug, the signal is not displayed because the corresponding hook switch has previously been operated; but in the case of a sub-station to be called, the supervisory signal is displayed because the plug and jack switch is the first to be operated, the hook switch in this case remaining unchanged until after the call is sent.

To enable the hook switch to control the signal, a low resistance relay is placed in the main circuit conductors of each plug, which relay being thus connected in the main line, is responsive to the closing and opening thereof as the hook switch is moved in one direction or the other.

The sketch Fig. 7 illustrates this arrangement, and shows that the relay in question does not act directly upon the local circuit of the lamp to open and close the same. This cannot be allowed because the same local circuit serves also for the operation of the cut-off relay and "busy test." It acts, however, by controlling a shunt round the lamp signal, closing the said shunt and preventing the display of the light when the main circuit is closed, and current consequently flows through the relay; and opening the shunt to permit the display of the lighted lamp when the receiver at the sub-station is replaced, causing the hook switch to open the main circuit so that current to excite the relay no longer flows.

In the figure, L L^2 are the sub-station circuits extending between the sub-stations S S^2 and the central station C, and adapted to be switched together for conversation at the latter. The switch-cord *c* has the battery B bridged between its main conductors, and has local circuit conductors for each plug, forming in association with the fixed conductor which unites the test rings, the local circuit; R R are the cut-off relays, R^2 R^2 the supervisory relays, *m m* the supervisory lamp signals and *h h* their controlling shunts.

The battery which develops the current for the main line to excite the relay, is, as shown, preferably bridged between the two main circuit cord conductors, which respectively unite the tip and forward sleeve contacts of the two plugs, and so connected, divides the cord circuit into two well-defined sections looping from each plug. The same battery provided with an earth connection at one pole, may serve also to furnish current in the local circuit to illuminate the lamp signal, and indeed also for the operation of the cut-off relay and busy test appliances; the several cir-

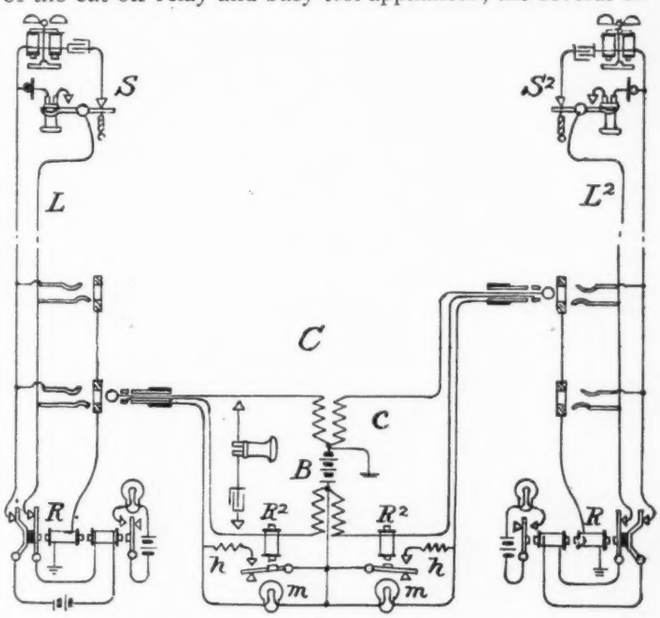


FIG. 7.

cuits being properly proportioned to the battery power and to one another by suitable resistances.

Another improvement tending to increased promptness of service in responding both to "call" and "disconnect" signals is the "pilot lamp." This is an auxiliary luminous signal which may be advantageously associated with both of the foregoing classes of regular signal. It complements the regular signals much in the same way that a bell in a hotel or domestic annunciator system is made common to and complementary to the several individual drops. This pilot lamp is thus common to the signals of a group of call signals, or to a group of the supervisory switch-cord signals, and it is adapted to light whenever any of the regular signals with which it is associated is displayed. It may be placed in a conspicuous position on the front of the switchboard, so as to be readily seen by the monitor or chief operator, and its protracted display is an indication that some signal of the group to which it belongs is being neglected or disregarded; or at any rate, that some signal of such group, thus far has not been attended to. It is by reason of this function that the term "pilot lamp" has colloquially been applied to the device; although I do not say that the term is eminently appropriate. The pilot lamp like the others is connected in a local circuit and controlled

by a relay, which may conveniently be placed in the circuit of the main conductor through which current is supplied to the branch lamp circuits of the group. This can readily be arranged in several ways without producing such an undue drop of potential in the branch lamp circuits as will adversely affect the regular lamp signals.

When the battery is bridged as has been described, it is properly connected for use also as the source of transmitter supply; and as has been suggested, may be and is so employed in connection, both with the transmitters of the several operators and those of the sub-stations. An important condition of success in the employment of a single battery for a large number of transmitters, is that its internal resistance shall be so low relatively to that of the circuits supplied, that the operation of any transmitter will not cause any material variation of potential at the battery terminals. When this condition is properly complied with, there will not be any interference between the circuits of the several transmitters; and such compliance is best attained by the employment of storage batteries. To further reduce the internal resistance of the battery and the chance of interference, a plurality of banks of cells, each bank having a sufficient electromotive force for the work—say 24 volts—may be connected in parallel with each other.

But another condition equally essential in the operation of the sub-station transmitters of an exchange from a common battery, is that by means of the switchboard devices and in their normal operation, it shall be possible at any time to disestablish this universal state of reciprocal neutral-

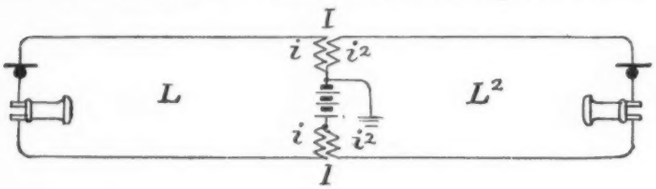


FIG. 8.

ity or non-interference as regards any two circuits, and so to segregate or set aside any pair or any number of pairs of circuits united for through communication, that the component circuits of such pair or pairs may freely communicate each with the other, but shall not disturb, or be disturbed by, any other circuits connected with the battery.

One plan of operation meeting this condition, which to a certain extent has been used, is to introduce a considerable impedance into the conductors connecting the main circuit strands of the switch-cord and thereby the main conductors of the two circuits concerned, with the pole or poles of the battery; and to establish a short-circuit, preferably containing a condenser, between the corresponding conductors of the two component circuits, and round the impedance. The steady current of the battery finds no further difficulty in flowing through the impedance devices than that due to simple resistance, and thus readily passes over the line in either direction to the sub-station transmitters, but cannot pass the condensers; while the voice currents developed by the action of the transmitters upon this steady current being in a state of constant and rapid fluctuation, are prevented from short-circuiting themselves through the battery bridge by the interposed impedance coils, but pass with great facility round these coils and through the patch which includes the condenser to the distant station.

Fig. 8, however, illustrates an alternative plan which thus far has found more general acceptance. It consists in associating the two united sub-station circuits L L^2 and the common battery B bridged at the central station between their main conductors, with an induction coil I of the type often styled repeating coils, wherein the two windings i i^2 have a like number of turns and like resistances. The two windings, as is clearly shown in the figure, are connected in the component circuits respectively, so that the circuits are in inductive relation with one another. Both windings are centrally divided, and the bridged battery unites the halves of both on one side to those on the other side of the circuit. Each component circuit is thus supplied separately with battery current for the transmitter of its sub-station through its own winding of the induction coil; and each is alternately the transmitting and receiving circuit. The voice currents developed by each transmitter circulate in the transmitting component circuit only, but acting through the induction coil they develop substantially identical voice currents in the receiving circuit also, which passing through the same, operate the distant receiver. This arrangement well complies with the second condition of success. It divides the circuit up into two sections, having no conductive connection, and thus tends to minimize the possible effect of a fault which may exist in either; and it reduces the adverse effects which otherwise would be very noticeable when the two lines connected differ considerably in length.

In Fig. 9 is illustrated the application of this plan for central and common transmitter battery operation to the switchboard apparatus; and furthermore, represents in diagram the sub-station and switchboard connections of two circuits, showing how the same central source of current may be employed in connection with call signals, circuit control and speech transmission.

I may in conclusion briefly advert to a minor improvement which in some installations has been added with a view to further relieving the operator of the time-consuming duty of following up sub-operations. This is a device combined with the ringing key, which acts after the key has been manipulated, to lock it in the ringing position with the call generator connected to line for a definite and supposedly sufficient period of time, or until the attendant at the station called, responds by taking the receiver from the hook. One way of arranging such a device is to provide a spring latch which when the key is depressed engages a shoulder on the key spindle; to mount the spring upon an armature; and to associate with each key an electro-magnet to act upon this armature, the same being wound with but few turns of coarse wire, and connected in the key branch of the generator circuit. The key having been pressed, is thus held in operation, because the current of the generator through the circuit (which, before the removal of the receiver from the hook at the sub-station is, as we have seen, kept conductively open by the inclusion therein of a condenser), does not excite the releasing magnets. But as soon as the call is responded to by the removal of the receiver from the hook, the circuit is conductively closed; and the generator current, now steady and strong, is sufficient to excite the magnet, which, attracting the armature, acts to release the key; so that the call current over the line is cut off. Such auxiliary devices, however, and others which have been suggested and which are intended to bring the operators' telephones into connection with a calling line as soon as the plug is inserted, and to disconnect them by an electro-magnetic switch after the lapse of a definite period of time, or when the companion plug is inserted, or when the call current is sent to the second line, present themselves to my mind, not as essentials of the switchboard apparatus, but as refinements of the lily painting or gold gilding order; which may be employed or not, and which do not alter the general character of the finished machine or effectuate any materially modified result.

There are, furthermore, certain concomitant appliances that have grown up round the switchboard as do suburbs round a city, and which should at least receive mention. These embrace mainly the power room apparatus for charging the universal storage batteries, and for the generation of alternating currents for outgoing calls; protective devices of several co-operative types interposed between the cable heads and the switchboard to arrest and guard against the effects of various harmful intrusive currents; the main dis-

tributing frame, an iron open-work structure with interior channels through which a multitude of insulated connecting wires are led, and having binding screw terminals of cable and switchboard conductors on its two sides respectively, between which such connecting wires extend to unite any pair of line conductors to any desired pair of switchboard conductors, and at which any circuit can readily be opened or otherwise altered for testing purposes; and the intermediate distributing board placed between the main distributing frame and the switchboard proper, where all main wires are represented and can be cross-connected, and at which to distribute the business equitably between the operators, any line while retaining its multiple switch-sockets can readily be connected or re-connected with any desired answering jack and line signal, and thereby be transferred in a few minutes from any switchboard section to any other, as the fluctuating character of the work may require.

While these appliances which in every large and well-appointed central telephone station are now uniformly provided as accessories of the switchboard, cannot within the reasonable limits of this paper be discussed in detail, they are of course to be kept in mind in planning and preparing specifications for the central station apparatus generally and the switchboard in particular; and their proportionment, design and relation to the switchboard with which they are to be associated, are matters which in each installation require the most careful and exhaustive consideration.

There is no great invention which has more thoroughly revolutionized business methods than the speaking telephone. The exceeding value of time is better appreciated now, than at any previous period in the world's history; and it is universally recognized that a business man's time is a business man's best asset. Wherever the telephone is employed—and it may truly now be said that "there is no speech or language where their voice is not heard," and wherever the telephone exchange has obtained a footing, there at once is a valuable economy of this most valuable possession attained.

It is, however, obvious that to realize this conservation and economization of time to the fullest extent, the possibilities of usefulness inherent in the telephone itself must be competently seconded by a central station switchboard through which all of the several operations and sub-operations requisite for the connection and disconnection of lines, can be carried out with accuracy and celerity. The Standard Relay Switchboard—as the organization of apparatus and circuits whose development I have traced has been entitled—is such an instrumentality; and by it, notwithstanding the marvellous increase of late years in the number of lines entering large central stations, and in the number of calls received and connections made in pursuance of such calls, the speed and efficiency of operation has been not only well maintained, but has exhibited marked improvement.

Here, then, at least for the present, we take leave of our theme. The efforts expended in producing the switchboard which for the time is standard, are amply justified by the general satisfactoriness of its work. True, its organization is complex, but so is that of every poly-functional machine; and why should we object to complexity if accompanied by corresponding efficiency; or unless it shall be proved that the same efficiency can be achieved by simpler means.

This switchboard, though not yet a perfect product of evolution, is at least a complete and successful machine; but evolution still goes on. It may well be that the next step in its never-ceasing progress will be in the direction of simplifying the organization either in its concrete devices or in its circuit arrangements, without any sacrifice of efficiency.

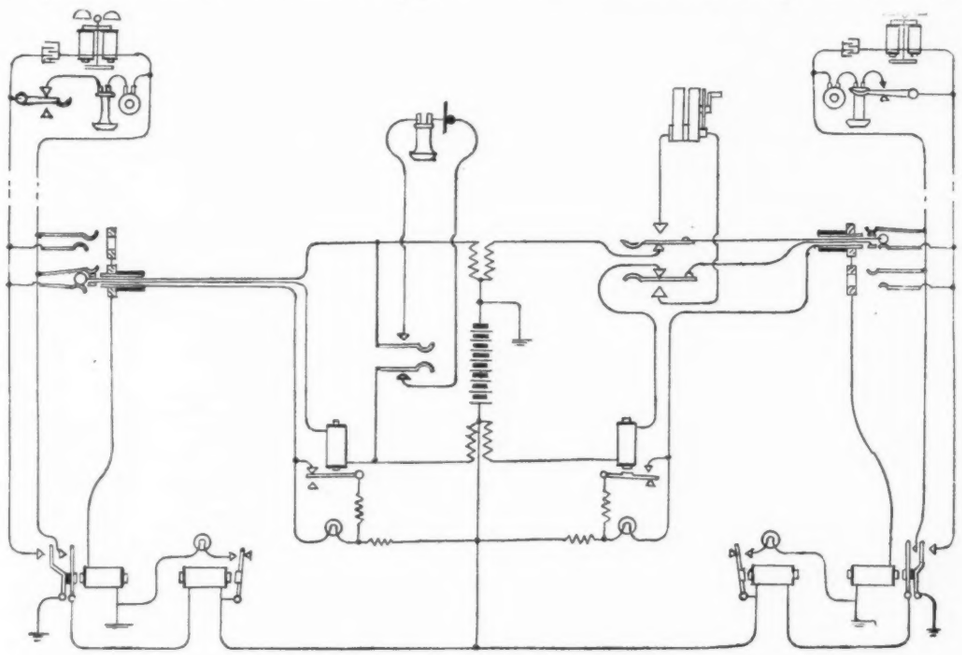


FIG. 9.

MEETING OF THE MICHIGAN INDEPENDENT TELEPHONE ASSOCIATION.

The annual meeting of the Michigan Independent Telephone Association was held at Lansing, Mich., on February 26. At a conference of the executive committee of the association, held in Grand Rapids prior to the meeting, matters of interest to telephone managers were discussed, and all in attendance expressed themselves as well pleased with the present situation throughout the state and with the growth of the individual companies. It was stated that not an Independent company had failed during the seven years' operation of the Independent system in Michigan, and that the outlook for the future gave evidence of a continuation of the present gratifying conditions.

A complete report of the meeting will be given in the next issue of TELEPHONY.

PRACTICAL TELEPHONY

Conducted by P. KERR HIGGINS, A. M. I. E. E.

ARTICLE IV.

Signaling Apparatus.—Calling or signaling is done in two ways, electric or magneto electric. Signaling done by primary battery is practically obsolete and is scarcely worth considering at this time. Signaling apparatus to-day then consists of a source of battery supply, appliance for operating, and a signal. Many plants are still using the magneto, and so we will consider this first. We have noticed in a previous article that magneto-electric currents are generated by the movements of a coil in a magnetic field. A magneto bell consists of four principal parts. (1) the generator; (2) the automatic cut out, (3) the ringer, (4) the gravity switch. The magneto generator is composed of a combination of two or more horseshoe magnets, so united as to form pole pieces, being held apart as in figure 1, and forming a space between the poles; this chamber is made of very soft iron and cut out so as to form a cylinder, into which

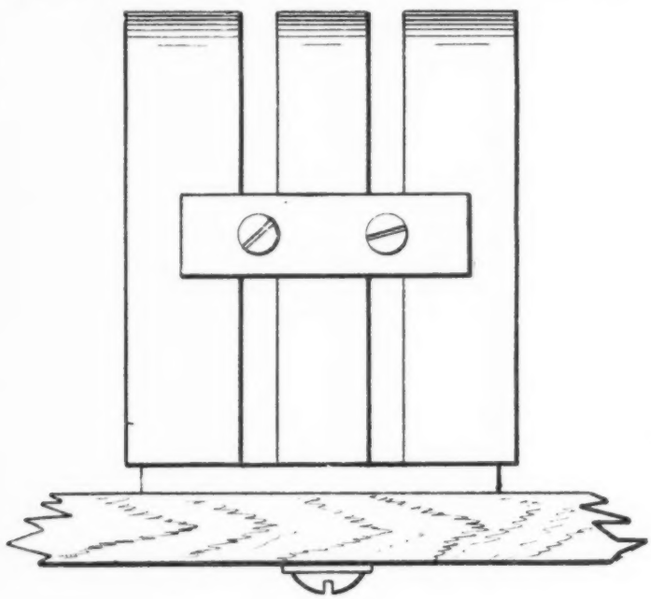


FIG. 1.

the armature fits. The armature (figure 2) is made of soft iron, in the space A (for series) is wound fine silk covered copper wire No. 34 B. & S. gauge, and usually to a resistance of 500 ohms and about 4,500 turns. Armatures can be specially wound to accomplish special work, and in specifying it is usual to state the resistance through which it is desired to signal and whether for bridge or series work. One end of the armature wire is fastened to the armature body, while the other is fastened to the insulated point (B) Fig. 3. This point (B) is usually insulated from the armature by a hard rubber bushing. The armature is revolved in the chamber between the pole pieces by means of driving gear, and this rapid movement induces in the wire currents which ring the bell. The strength of the instrument depends (1) on the form of the armature, (2) the resistance of the coil, (3) the strength of the magnets, (4) the perfect fitting of the magnetic field and its auxiliaries. The ends of the chamber are usually of brass and the armature is pivoted through this at both ends. The magnets are clamped to the pole pieces by iron plates fastened with screws. It is scarcely necessary to state that all the poles of same polarity should be together. On the opposite end of the armature, to the insulated point is a small toothed

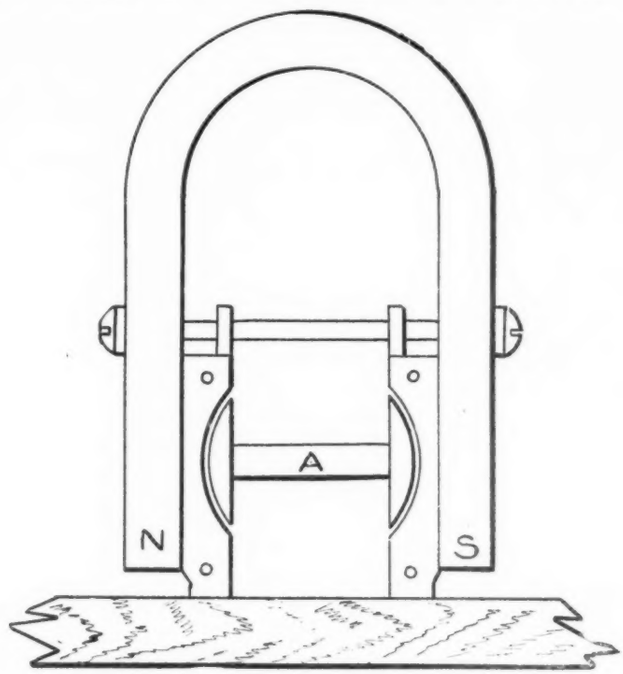


FIG. 2.

driving wheel which fits into a larger one carried on the shaft, and is driven by a crank handle, outside of the box proper. In the construction of these parts, it is absolutely

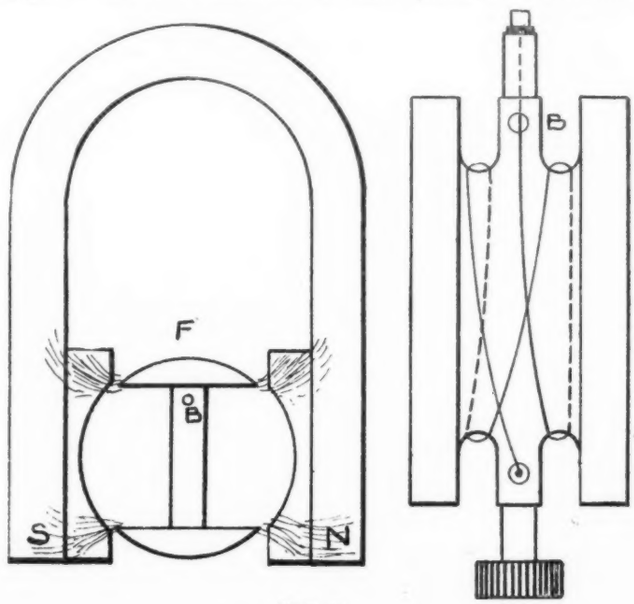


FIG. 3.

necessary that they all fit exactly, in order to insure smooth and efficient working. It will be noticed, as the armature poles pass through the magnetic field, there is a zero point F (Fig. 3) that is a point where the current changes from

positive to negative, and at right angles to this (G. Fig. 4) the maximum current is induced. The size of the armature generally used for the hand generators is about 1½ inches diameter and the space or chamber in which it is fitted about two millimeters larger, or just enough to allow the armature to move freely. The space in the chamber forms a strong magnetic field with the lines of force running across from one pole to the other. Naturally a coil revolving rapidly in this field and having a soft iron framework will vary

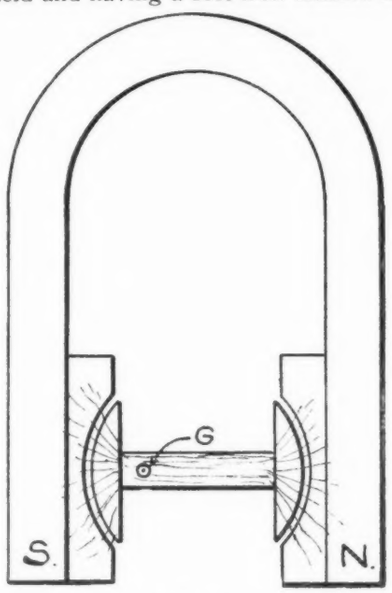


FIG. 4.

these lines of force, and the greatest variations will take place when the armature is straight from pole to pole (Fig. 4). The direction of the current alternates with each half revolution and so a complete turn gives rise to two impulses, producing an alternating current. In some of the latest generators this is taken advantage of and the spring resting on the insulated point is split, the point is also so

FIG. 5.

constructed as to be metal one-half and hard rubber the other. By placing the whole spring on top (Fig. 5) a direct current is obtained, and by placing half on top and half on bottom an alternating current. The faster the armature is turned the greater the variation in current and the higher the E. M. F. The induced action may be explained in

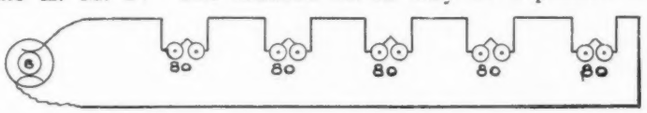


FIG. 6.

another way, namely, that the iron frame of the armature is magnetized by the lines of force and its polarity is changed twice in every revolution, each of these changes inducing, in the wire surrounding the core, a current in opposite direction to the preceding one. It will, therefore, be seen that the core of the armature should be of very soft iron. As in the case of a magnet the lines of force near the center of the armature are weak, there is no necessity for wire, and this accounts for the peculiar shape of the armature. It is well to note here that the width of the pole pieces should be exactly the same as the armature poles, for the reason that during the time they cover each other there is no current produced, and further the inductive changes are not so marked and less liable to produce electrodynamic induction on adjacent lines, when the possibility of this exists.

In series work, as is apparent in Fig. 6, the object is to ring through a succession of bells joined in series. (See illustration.) To accomplish this we need a generator producing high voltage and a small quantity of current. This pressure is necessary to drive the current through the bells at the stations as shown. The voltage necessary to ring a given number of stations can be obtained by first obtaining the voltage necessary to operate one bell and then multiplying the result by the number of stations. To obtain the amount necessary to ring one bell we use Ohm's law—C=E/R. The condition of the line as to insulation, capacity and also the condition of the ringer coils must be taken into account, as the result will vary in proportion as these

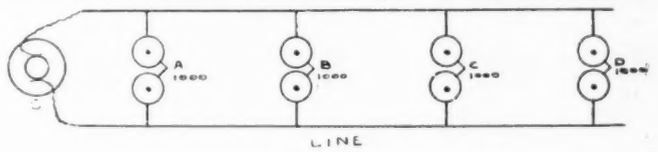


FIG. 7.

vary. On a well insulated line (aerial) the resistance and condition of ringers is all that need be noticed.

In bridging work, by reference to Fig. 7, it will be seen that the object is to ring across instead of through the bells. To obviate too much loss at any one station, coils, of high resistance and reactance (self-induction) are used; these because of the self-induction are approximately fifteen times their specific resistance. It is usual to make them 1600 ohms. It is apparent that the current, if all the bridges are equal, will dissipate itself uniformly at all the ringers, provided that the initial current is strong enough to reach the last station. Reducing the resistance at any point along the line will produce a whole or partial short-circuit, and such a short-circuit would affect all the bells. It will be seen that the opposite of the series magneto is desired, namely, high current output. These generators

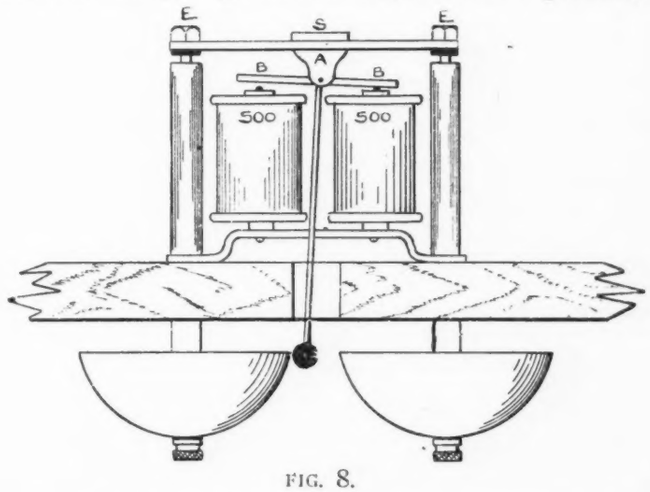


FIG. 8.

are usually wound for 75 to 100 volts, resistance 275 ohms, 3900 turns.

When the generator is at rest it is necessary that its resistance be cut out of the circuit and for this purpose the automatic cut-out has been provided. Many devices have been introduced to accomplish this, the earlier being confined to the armature, and the more modern being operated by a spring on the driving shaft, producing a tension, which, when at rest, pushes the main body of the generator contact away from the connecting point. This is done by making it necessary to use more force to turn the crank,

and in doing so the pin is moved up the v-shaped cut, on the spindle, releasing the pressure on the spring and permitting it to come in contact with the connecting point. All devices work on this principle, the only difference being in the location of the springs. The idea being that the coil of the generator is cut out when the generator is not in use, and this may be done either by shunting it or by leaving the contact open.

The troubles usually found in the generator are (1) open, (2) short-circuits, (3) weak magnetos. The tests generally applied are: test each part with a battery and bell, or the fingers.

The induced currents produced by the generator are alternating in character and follow each other very rapidly, hence two things are kept in view in the construction of the ringer: (1) Must be very sensitive, (2) a strong stroke. They are made in two styles—series and bridging. In the former it is usual to wind the coils to 40 ohms each, using No. 30 B & S silk insulated wire; the latter to 1600 ohms, using No. 36 B. & S. The arrangement in general practice is as seen in Fig. 8. The ringer best suited to rapid frequency is polarized.

The gravity switch is shown in Fig. 9, and it will readily be seen that the object of the switch is to provide an automatic means of changing conditions so as to cut the battery and the bell in and out of circuit. When the receiver is hung up the local talking circuit is cut out, and vice versa.

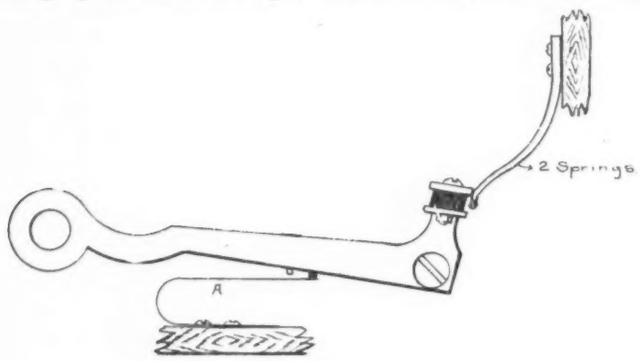


FIG. 9.

The contacts should be platinum tipped and have a rubbing contact. The lever, actuated by the receiver and the spring A, is long. The change is made slowly with great certainty and the pressure on the contacts is strong and uniform. By tipping the contacts with platinum oxidization is avoided. In the case of bridging magnetos the ringer coils are permanently bridged.

The talking efficiency of a telephone depends in great measure upon the battery. Modern systems supply battery from the central office; but as there are still a large number of local battery systems in use and as this system is almost universally used on toll lines, we will consider some of the best types. Local batteries are divided into two main classes: (1) primary, (2) secondary, and again subdivided into open and closed circuit. For single substations storage (secondary) battery is not found to be convenient. Primary batteries are of two kinds: (1) dry, (2) wet.

The price of dry cells has been so reduced that many companies are using them exclusively for instruments at sub-stations. The "Pacific Coast Telephone and Telegraph Co." use three dry cells for each telephone, and many Independents are doing likewise. They are convenient, time-savers and can be easily changed. They are portable and their low cost makes them real economy when a local battery is desirable. I have found that the dry cell gives out suddenly.

The Le Clanche cell has been standard for many years, and while manufacturers have called the cell by their name, having made some slight change in the arrangement of the electrodes, yet the principle of the cell is the same. In all forms the electrodes consist of a carbon plate, or cylinder, or a porous cup containing powdered binoxide of manganese and a carbon rod or plate; the other electrode is either a sheet or a rod of pure zinc. The electrolyte consists of a solution of sal-ammoniac and water, about four ounces of commercially pure sal is usually sufficient for one charge. The voltage is about 1.46 and the cell has very little local action. The current decomposes the sal-ammoniac solution into chlorine and ammonia.

The Fuller cell is an excellent one for long distance service. It is a bichromate cell and consists of a glass jar containing "electropoion" fluid diluted one-half. The porous cup contains a little mercury and a zinc formed like a cone; attached to it is a copper wire extending through a wooden top, which covers the glass jar. The object of the mercury is to keep the zinc amalgamated. The copper wire must be amalgamated. This is done by dipping the zinc and its wire into the "electropoion" fluid and holding it there for a few moments, then dip it in mercury or rub mercury on it. In the porous cup is placed a little salt; the cup is then filled with water to the same height as the fluid in the glass jar. The E. M. F. of this cell is 2.15 volts. When the cell is exhausted or nearly so, the fluid changes from a red to almost black or a blue-black; then the fluid should be thrown out and new put in. The zinc also should be cleaned or renewed as is found necessary. The carbon element is passed through a slit in the wooden top and into the fluid in the outer jar.

The gravity cell is a peculiar one. The most common form is known as the crow-foot. The cells are usually 6½ inches by 8½ inches. Copper strips are riveted together to form the shape of a star, with an insulated wire attached to them. This forms the copper electrode and is placed in the bottom of the glass jar, crystals of copper sulphate are dropped into bottom of the jar, the zinc is hung on the edge of the jar, in the solution, by a lug. The condition of the cell can readily be ascertained by its color, which should be a deep blue at the bottom and extend half way above the copper plate. This cell is used exclusively on closed circuit work, such as switchboards, etc. Porous cups are usually past repair when they become a rusty color. The resistance of connecting wires from the battery to instruments should be almost nothing.

KANSAS INDEPENDENT TELEPHONE MEETING.

About one hundred managers of Independent telephone exchanges in Kansas met in Topeka on January 28, 29 and 30. A contract was made with the Kansas City Independent Telephone Company to connect Kansas City and Topeka by an Independent system within four months; Topeka and Wichita and Topeka and Belleville within six months.

Among the papers read at the meeting were: "The Engineering of the Kansas City Exchange," by M. C. Polk; "Progress in Southeastern Kansas," by M. L. Robeson, of Galena; "Hic Jacet Berliner," by Charles E. Wells, of Marion, and "Our Needs As I See Them," by W. H. Nelson, of Smith Center.

New officers of the association for the coming year were elected as follows: A. A. Godard, of Topeka, president; J. M. Doyle, Belleville, vice-president; Charles V. Wells, Marion, secretary, and J. W. Smith, Minneapolis, treasurer. The new executive committee is composed of C. H. Munsell, Hiawatha; J. E. Byers, Ottawa; W. H. Nelson, Smith Center, and A. R. Champlin, Newton.

I have received TELEPHONY since its first number and am highly pleased with it.—Nick Ed. Haberman, Cleveland, O.

DECISIONS AFFECTING TELEPHONY

Conducted by ANDREWS & MURDOCH, Berrien Springs, Michigan.

EXCLUSIVE FRANCHISE.

In an action by the Muskogee National Telephone Company against R. F. Hall and G. W. Pitman, the complainants claimed the grant to them of an exclusive franchise to operate a telephone line within the Creek Nation, and sought to enjoin the defendants from erecting a line in the town of Tulsa in said nation. The Creek Nation also prayed for a similar injunction, claiming property rights, that it was interested inasmuch as it was entitled under the terms of the franchise granted to a royalty of five per cent upon the net earnings of the Muskogee National Telephone Company, and their earnings would be lessened by the operation of another line which was being erected without any authority from it.

Circuit Judge Thayer, of the United States Circuit Court of Appeals, which court was reached through successive appeals, has filed an opinion in which the court grants the injunction as to the Creek Nation, but decides that the telephone company takes nothing for its suit, in the course of which opinion he says:

"That the Creek Nation had no power to grant an exclusive franchise such as it attempted to confer is settled, we think, by the decision in Pensacola Tel. Co. vs. W. U. Tel. Co., 96 U. S. 1, 8, 24 L. Ed. 708, where precisely such a franchise, granted by the state of Florida as respects only two counties of that state, was adjudged to be invalid. It is true that in the latter case the franchise that was held to be invalid had been granted to a telegraph company; but telephone companies are equally agencies of interstate commerce, and every reason which was or that may be assigned against the grant of a monopoly to maintain telegraph lines applies with equal force against the grant of such a monopoly to a telephone company. Telephone companies, like telegraph companies, are common carriers of information, and their lines are daily employed in the transaction of interstate commerce. Some courts have held that a telephone company is included by the words "telegraph company." Southern Bell Telephone & Telegraph Co. vs. City of Richmond (C. C.) 78 Fed. 858, 860, and cases there cited. But, be this as it may, telephone companies, like telegraph companies, are important agencies in the transaction of interstate commerce, and no state can grant to one telephone company the exclusive right to operate telephone lines within its borders; and what a state cannot do, because it operates as an obstruction to the free flow of interstate commerce, the Creek Nation (which is said to embrace as much territory as some of the states) cannot do. It is well settled that, in the exercise of its power to regulate commerce among the several states and with the Indian tribes, Congress has full authority to grant rights of way through the land occupied by the five Indian tribes domiciled in the Indian Territory for the construction of railroads (Cherokee Nation vs. Southern Kan . Co., 135 U. S. 641, 10 Sup. Ct. 9665, 34 L. Ed. 295; Stephens vs. Cherokee Nation, 174 U. S. 445, 485, 19 Sup. Ct. 722, 43 L. Ed. 1041); and in the exercise of this power it has recently authorized the Secretary of the Interior to grant rights of way through the Indian Territory for the construction, operation and maintenance of telephone and telegraph lines. 31 Stat. 1083, c. Sec. 3. It follows, of course, that none of these tribes had the power to declare that any one telephone company should have the sole right to construct and operate telephone lines within its borders, since the existence of such a monopoly would have a necessary tendency to prevent free communication between those who reside outside of, and those who reside within, the territory. To this extent the grant of such a franchise as the one in question operates to obstruct interstate commerce."

Muskogee Nat. Tel. Co. vs. Hall et al., 118 Fed. Rep. (U. S.) 382.

WRONGFUL DISCONNECTION.

G. A. Hendon, a physician living in Louisville, Kentucky, was a patron of the Cumberland Telephone & Telegraph Company, and had one of its instruments in his office. The company discontinued the telephone from 3 o'clock p. m. of one day to 8:45 o'clock the next morning, a something less than eighteen hours, and Dr. Hendon brought an action against it for damages therefor. Recovered a judgment for $200 in the trial court, which the Court of Appeals of Kentucky has just reversed, ordering a new trial, on appeal of the telephone company. The opinion is as follows:

"The reason the telephone was disconnected was that the bookkeeper made a mistake in posting the amount paid. His book did not show that Hendon had paid for the month of September, although he had in fact paid. On October 22 a notice was sent to him that his 'phone was discontinued for this reason, and, he having paid no attention to the notice, twenty-four hours afterwards the connection at the office was severed, although the instrument was not removed. When he got home at 6 o'clock that evening and found that he had been cut off, he tried to 'phone to the office, but failed to get them. The next morning he went down, the mistake was at once corrected, and the instrument was no longer discontinued. The proof showed that he had not only paid for September, but had also paid in advance for October, November and December. It also showed that one person who needed the doctor for his wife that night, being unable to reach him by 'phone, walked to his office and waked him up. It also showed that three other persons who wished to talk with him were unable to reach him on the 'phone, and that, when one of them asked at the office what was the matter, the assistant manager answered that his 'phone had been discontinued for non-payment of rent. It is not shown that he suffered any pecuniary loss by the suspension of the service, although it would seem that he was considerably annoyed about it. On these facts the jury found for him a verdict for $200, on which the court entered judgment. The court instructed the jury that they should find for the plaintiff at least nominal damages, and, if they believed from the evidence he suffered inconvenience by reason of his telephone service being discontinued, then they should further find for him such sum as would fairly and reasonably compensate him for the inconvenience so sustained. There was nothing in the case to warrant an instruction on punitive damages, and the court properly refused to instruct the jury on this subject. The plaintiff had by contract acquired the right to a certain service, and, this contract being broken, the measure of damages is compensation for the breach, as in other cases of broken obligations. The case is entirely different from those where there is a physical trespass, as in the case of the expulsion of a passenger from a train, where there is not only a breach of contract but an actual tort. The proper measure of damages to compensate for the breach of the contract is a matter of some difficulty, and

we have been referred to no authorities directly in point. Where the contract is to deliver a specific message, and is broken, the measure of damages has been often adjudicated, and we see no reason why the same principles should not apply to the case before us, for the contract here was in substance an undertaking to convey all messages the subscriber might wish to send, or others might wish to send to him, over appellant's line, within the time paid for by him. In the absence of proof of special damage for the failure to carry a message, the recovery would be limited to the amount paid for the service which was not furnished. Mere inconvenience or annoyance cannot be recovered for except in peculiar cases. 25 Am. & Eng. Enc. Law, 855-8663; Chapman vs. Telegraph Co., 90 Ky. 265, 13 S. W. 880. Where there is a contract, not for a specific message, but for the carriage of all messages within a certain time, the refusal to carry any messages for a certain part of the time is a breach of contract not different in character from the neglect to carry a specific message, and the measure of damages, in the absence of any proof which it is refused. In case of special damage, this, in addition, may be recovered under proper averments. Robinson vs. Telegraph Co. (Ky.) 68 S. W. 656, 57 L. R. A. 611. Under the evidence, the court should have instructed the jury to find for the plaintiff the amount paid by him for the service for the time his 'phone was discontinued, taking for the basis the amount paid by the month, and allowing for the time lost such part thereof as they deemed right."

Cumberland Telephone & Telegraph Co. vs. Hendon, 71 S. W. Rep. (Ky.) 435.

A Special Inspection.

By A. E. DOBBS.

CONCLUDED FROM JANUARY TELEPHONY.

We first take the voltage reading of our battery, making careful note of its reading in tenths of an ampere. Now connect the resistance it is desired to ascertain in series with the battery and voltmeter. It will be found that there is a falling off in the voltage, but, as we know that each degree of the scale represents one mil ampere, we now read the deflection as representing so many mil amperes instead of volts or tenths of a volt.

This brings us back to our formula again: If $I = \frac{E}{R}$ it also follows that if we have the terms, E and I, by a simple transposition of terms $R = \frac{E}{I}$

Now, for example, having a battery giving a pressure of 2.8 volts, we connect a transmitter in series and obtain a reading of 1.9 volts or, rather, 19 mil amperes. What is the resistance of the transmitter?

Answer: $R = \frac{E}{I}$. 2.8 (volts) $\div$ .017 (amperes) = 165 ohms; but, as we must deduct 100 ohms, the resistance of the voltmeter, we have a net result of 65 ohms as the resistance of the transmitter.

Example 2: With the same battery we measure a line and get 6 degrees (6 mil amperes) deflection. What is the resistance?

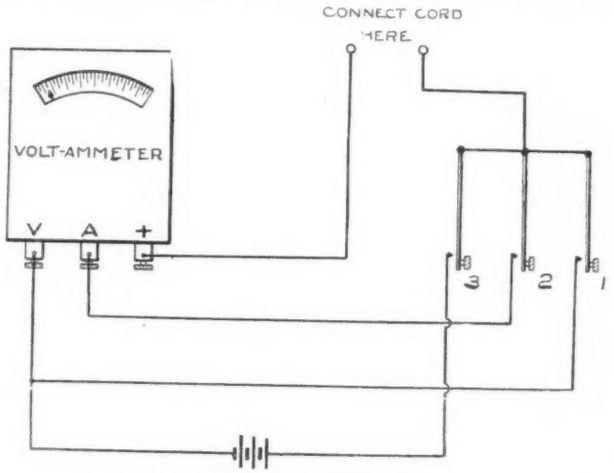
Answer: 2.8 $\div$ .006 — 100 = 366 2/3 ohms.

A voltmeter test is not as accurate as one made with a good bridge, but at the same time it is near enough to indicate whether the line is all right or not, for, if the resistance of the line, including the drop, should be 175 ohms and we got only one degree deflection, which would in the above case mean about 2,700 ohms, we would know at once that something was wrong and make a report indicating a bad condition or something similar.

In measuring the resistance of the line disconnect one wire from its binding post, connecting the voltmeter to the free end as well as the opposite post, which gives the resistance of the line through the drop. If it is desired to measure the ringers, leave the wire free and measure back through the posts with the hook down. With the switch hook up you can also get the resistance of the receiver and induction coil. Should it be desired to measure the receiver alone, disconnect one of the binding posts and measure through the cord.

The voltmeter also makes an excellent detector galvanometer and can be used to detect grounds or crosses in the apparatus. It is not accurate enough, however, to take the place of a Wheatstone bridge in locating line trouble, because, if the line should be a long one and the resistance to the fault rather high, one or two degrees of the scale will make a difference of perhaps two or three miles in locating the fault.

An excellent form of test set for the inspector to carry around is shown in cut, which is a combined volt and ammeter in one instrument, reading to 5 volts on the upper scale, 14 amperes in the lower, which can be fastened on top of a box large enough to contain two cells of dry battery in an upright position. The connection to the various parts of the instrument is made with a flexible electric lamp cord (No. 14 perferred), to the ends of which are fastened



VOLT-AMMETER TEST SET.

two clips large enough to firmly clasp any binding posts likely to be met with.

On the side of the box are located three push buttons, numbered 1, 2 and 3 in the drawing.

On going to the instrument first open the battery box and connect the cord to the battery, taking care to connect the + of positive clip to the carbon and the negative clip to the zinc side and press button No. 1. This gives the voltage of the local battery, which, when ascertained, press button No. 2 for ampere readings.

[It might be said right here that when a battery gets down to 0.25 of an ampere it is time to have it changed, and a note to that effect should be inserted in the remarks if the inspector does not carry batteries with him. Sometimes it happens that a battery indicating as high as two volts will have a very low ampere reading, but .25 of an ampere

should be the limit which a battery should not be allowed to pass.]

We now wish to ascertain the resistance of the transmitter. There are two methods of doing this; one is to connect the voltmeter in series with the battery and raise the hook, at the same time pressing down on button No. 1. Another is to open the battery circuit, connect to the wire and, by pressing button No. 3, make use of your own local battery in the test box. The latter is probably the best way, as this battery is more apt to be constant, which makes calculations easier.

In the formula given above the calculation seems more complex than it really is. Suppose your test battery is 2.8 volts and your transmitter reads 2.1 volts. Simply by adding two ciphers to the 2.8, so as to have three decimal places, we would have $2.800 \div 21$, which can generally be performed without the use of a pencil at all with a little practice, even the 100 ohms resistance of the voltmeter being deducted from the first figure. With a constant battery an inspector will soon have a set of constants committed to memory.

A good dry battery in proper condition will remain fairly constant after the first day's work and can be depended upon for several weeks.

In measuring the resistance of a transmitter tap it gently and move it up and down a couple of times, thus obtaining an average of all the readings.

In calling the chief operator for test of talking service note the time taken in answering and make a report of it on the slip.

A man who attends to his duties can inspect from twenty to thirty telephones a day.

After the slips are turned into the office they should be entered on a long sheet of paper ruled and marked under proper headings and results obtained from telephones of different manufacture tabulated. The result will be an interesting study for the manager, as it will enable him to determine which instruments are giving the best service, and, with the results before him there need be very little guess work about it. Remember, however, that for accurate measurement of line resistance a voltmeter does not compare with a good bridge, and the object of this paper is to show how to get along fairly well with a comparatively cheap instrument.

Reference has been made above to measuring lines from the subscriber's instrument instead of from the office. It cannot be denied that if all ringers had the same winding the work could be performed much more expeditiously from the cross connecting board, but in an exchange where the resistance of the ringers will vary from 40 to 500 or 1,000 ohms the results are apt to be misleading. The switchboard drops, on the other hand, will all average about the same, say 100 to 150 ohms, with not more than 10 ohms variation, which, when deducted, will give us the resistance of the line itself.

One trouble that may be met in this connection, however, lies in the character of the protective devices employed, for there are many heat coils used in exchanges that have a resistance varying from 20 to 100 ohms, and these should also be tested and deducted from the total reading in order to find what the line resistance actually is. Still, as these heat coils form part of the circuit at all times, unlike that of the ringers and drops, this may be omitted except as a matter of general interest in order to account for variations in the resistance of lines of approximately equal length. It may be explained in this connection that two heat coils, one rated 0.1 and the other at 0.5 of an ampere, will have about the same proportionate variation in resistance, the more sensitive being the greater. As many fuses of different capacities may often be found on the same strip, this is important.

RECEIVER TROUBLES.

Receiver trouble is one that the inspector will frequently meet with.

It is surprising how many receivers will get out of adjustment, although receivers made two or three years ago were much worse than those of the present time, as there is a keen competition among manufacturers to produce those forms which experience has shown to be the best, and there is slow but sure improvement in all of them. The receiver giving the least trouble is generally secured to a cup set in the shell at a point as close to the magnet spools as possible. By this means expansion and contraction of the magnets is, with the exception of not more than one inch, back toward the lower end of the handle, where there is plenty of room, instead of toward and from the diaphragm, as in the older forms, which were fastened by a screw at the back end.

It frequently happens, however, that the constant strain of the magnet upon the diaphragm will cause it to bend downward toward the center, thus allowing it to touch the magnets that it may have cleared by the thirty-second of an inch when it left the factory. This fault can generally be remedied by turning the diaphragm over, but in cases where it cannot some way must be found to push the spools down the required distance or build up the shell rim. Some receiver cups are set in the shell by means of a screw thread, which by turning around will raise or depress the magnets the required distance. Some manufacturers, however, fearing, and not without reason, to trust the adjustment of their receivers to the average country "electrician," purposely make them non-adjustable. This, however, is, I think, a mistake, for the best made receivers will go wrong occasionally, diaphragms will buckle in time, or, if the adjustment is wide enough to prevent this then a falling off in the strength of the permanent magnet will in time produce a weak receiver.

But if the receiver diaphragm is the right distance in the first place there should be about one thirty-second of an inch clearance. Then if buckling of the diaphragm takes place or the pole pieces work up and the receiver is of the non-adjustable variety, the only thing that can be done is to cut a sheet of paper in the form of a ring and place on the rim of the cup underneath the diaphragm. This will generally afford the proper clearance, though not a very workmanlike expedient, but there are cases where it is the only thing that can be done.

The strength of the receiver magnets should also receive attention, for in an inspection like this quite a number will be found that are getting weak. A good plan would be for the inspector to carry a piece of soft iron as bulky as possible, weighing about twelve ounces. If the receiver holds this weight the magnets can generally be passed as satisfactory.

This test is not necessarily conclusive, for a weak magnet with a thin, light, elastic diaphragm will often do better work than a much stronger magnet with a heavy, sluggish diaphragm. In fact, the very strong magnets are at a disadvantage in this regard, for, as time passes and they begin to lose strength, the very thick diaphragms that originally went with them are not light and elastic enough to respond readily and it is sometimes necessary to replace them with diaphragms much lighter than those first sent out in order to retain their good talking qualities, though the thick diaphragms are more powerful as long as the magnets retain their full strength.

One more cause of receivers losing their adjustment is found in the composition imitation of hard rubber, which is often a cheap wood fiber. This material will often shrink or warp on exposure to damp or muggy weather, so that in some cases we have the magnets badly out of adjustment or in the other the ear piece may buckle down far enough to touch or nearly touch the diaphragm, to which a few

added particles of dust is all that is needed to produce the faint tones that come from muffling of the diaphragm. This trouble is very apt to be mistaken for line resistance, but a talking test with the chief operator will develop the fact that she can hear you quite plainly, while you can hear her but faintly, which proves the trouble to be purely local. Besides the voltmeter should show whether the line resistance is abnormally high. In this case the only thing that can be done is to heat the ear piece over a flame of some kind and bend it outward till it clears the diaphragm. It will probably talk better if it curves slightly outward.

Another trouble sometimes met is that of a grounded or short-circuited receiver. In this case the receiver is weak, though the diaphragm is the proper distance and the magnets of proper strength. To locate this trouble disconnect the receiver and take a voltmeter reading. If the reading shows a receiver resistance of much less than 75 ohms there is good reason to think that some of the layers of wire are short-circuited on each other. Sometimes this may be traced to the induction coil, which may also be measured by short-circuiting the instrument, letting the hook come up and measuring the resistance through the binding posts of the receiver with one side of the cord disconnected.

Sometimes the magnet windings will be found grounded on the metal cup or shell of the receiver. If the cup is entirely protected no special harm is done, but if the metal is exposed there may be danger to the subscriber, and a receiver of this kind should be changed or repaired without delay. There is still another cause of trouble in new receivers caused by iron filings settling in, in some way, and gathering on the ends of the magnets.

Receiver cords should also be tried and tested to see that there are no broken strands, and also all binding-post screws examined to see that they are tight and firm.

THE TRANSMITTER.

One of the most common transmitter troubles is "packing," which is caused by the particles of carbon adhering together or becoming tightly wedged in such a way as to almost short-circuit the battery. The symptoms are a loud click in the ear when the hook comes up, but not a sound, or at least only a faint one, will the transmitter send over the line. This trouble can generally be relieved by a sharp, light tap on top of the transmitter or moving the arm up and down a time or two.

Sometimes, again, this can be permanently relieved by opening up the cup and removing a few granules of carbon from it, for some cups are filled too full of granulated carbon to give good transmission. The carbon cup will give the best talking effect which is filled only about two-thirds full of granules. Some manufacturers put in more than this, but the result is generally a dull, sluggish response to articulate waves and greatly increased liability to packing. Some transmitters—and all should be—are more or less adjustable, in which case the remedy for a too full or too shallow cup is easy. If not adjustable, the cup must be taken apart and carbon taken away or added till it is just right. One precaution only is necessary: carbon should not be taken in the hands, as their moisture will spoil it. When necessary to take the carbon out of the cup pour it out on a piece of dry paper, and when ready to put it back crease the paper and pour it back without letting it touch the hands at all, for one of the greatest enemies to good carbon is moisture, which makes it important that the general run of telephones should be kept in a reasonably dry place.

The general practice in the testing of a transmitter is to short-circuit the instrument, take down the receiver, say "Hello" a few times and judge by the return effect in the ear. This plan, however, is not a very reliable one, for many a transmitter giving a strong back tone gives but a very indifferent talking service.

Therefore it follows that the final test should be made with the chief operator or wire chief, which not only satisfies the office, but in case of dispute as to what was actually done there are two witnesses of the actual condition.

Troubles with the cord or cords leading from the head of the transmitter to the base of the arm are also frequent, especially on those of the older style, in which the cord is outside of the arm, an arrangement which now is happily being discarded for the hollow arm and concealed wires.

Another cause of sluggishness in transmitters is sometimes to be found in the dampening springs used on some diaphragms. Once in a while these springs shift their position or the rubber or felt placed beneath them becomes hardened or brittle, which may loosen the spring and cause it to rattle, or the rubber may stick to the diaphragm and cause sluggish action.

Weak construction is a frequent cause of a "roaring" transmitter, the cups being formed of very thin sheet metal and the back electrodes mounted on a very weak support. Within the last year or two, however, manufacturers are making the support for the back electrode (bridge, it is generally called) of a solid piece of metal connected to a solid iron arm, with the result that the transmitter has been greatly improved in its talking qualities. With weak mechanical construction, of course, there is nothing to do but to replace the transmitter with a new one as soon as practicable when it begins to go down. Some manufacturers, we regret to say, still use the iron arm as one side of the circuit, which is objectionable and leads to constant trouble. With this kind the hinge of the arm should be inspected and care taken that they are left bright and have a firm rubbing contact.

INDUCTION COIL TROUBLES.

Many induction coils will do good service for years and years without trouble of any kind, while others will begin to make trouble almost as soon as they are out of the shop. Some of these coils, of course, are better made than others, but, on the other hand, some are much more exposed to high potential or static discharges than others. A coil smoothly wound, other things being equal, has a much better chance for a long life than one in which the various turns and layers cross one another irregularly, although, as long as it lasts, there would probably be little or no difference in talking qualities. When an induction coil goes wrong that fact is, generally, so plainly manifest that there is little delay in sending a man around to see about it. Still, a coil may be quite weak without attracting any special attention, except, perhaps, a chance remark by the operator that "333 doesn't talk a bit good."

In testing these coils it is pretty hard to measure the primary winding with our voltmeter, but it is easy to measure the secondary from two points, providing the switch-hook contacts are all right and the wiring correctly done. One place is at the receiver binding posts with the line posts short-circuited, or *vice versa,* at the line posts with the receiver cut out. Then by removing the shunt across the receiver terminals and taking a second reading we get the resistance of both receiver and secondary coil.

Now the question as to whether any turns of the coil are crossed with each other must depend to a large extent on personal experience and observation.

Suppose it is known that the induction coils sent out by a certain manufacturer measure an average of 225 ohms each. If now we should find a coil weak and find its resistance to be only 180 ohms, we would naturally think that two layers of this coil must be crossed with each other, as there is a falling off of 45 ohms, which indicates a sufficient number of turns to set up a considerable amount of counter e. m. f., thus weakening the entire coil.

A cross between the primary and secondary coils will also make trouble, but this can be easily found with any ordinary test set.

Probably the meanest trouble of all to find is one in which the secondary wire has been broken underneath the covering and the ends separated just far enough to remain open part of the time only and remain closed while the inspector visits the house. A voltmeter, if placed in the circuit, however, will generally detect this trouble if the box is jarred slightly, for instead of coming to rest the needle will keep traveling back and forth over the scale, a sure indication of variable resistance, which, however, must not be mistaken for the variable currents introduced into the coil by sound waves.

OTHER TROUBLES.

If properly adjusted ringers, with the exception of an occasional burn out, make very little trouble. The ringer armature should be as close to the pole pieces as practicable, but far enough away to give the clapper a considerable swing in order to attain the proper striking force, say from one-sixteenth to one-twelfth of an inch.

Desk sets generally have some troubles of their own, such as fraying of the cords by which they are connected. They are also generally secured to wooden blocks and sometimes, I regret to say, with the ends clamped under wood screws. Wrong connections between cords and terminals are of frequent occurrence with these sets. For tracing these connections nothing can excel a voltmeter in the hands of an experienced inspector, for he learns to tell by the drop in his readings just which is the induction coil, which are "shorted" on the switch, which the transmitter and so on down the list.

In some of these sets with outside switch contacts there is considerable trouble from dust and grit, which should be looked after and contacts wiped clean with a sheet of rough linen writing paper, which will be found better than emery, as it does not scratch the points and brightens them effectively. A clean, thin piece of wood, as soft pine, is also very effective in the polishing of switch points.

It is also a good plan to clean and polish up the bells and other parts of the instrument when on the rounds, as it creates a good impression.

It is bad practice to put oil on the hinges of either the switch or the doors; some kinds of oil would do no harm, but most of us are not chemists enough to analyze them.

One curious cut-out sometimes found in desk sets is caused by the receiver hook becoming bent down far enough to let the receiver just touch the base of the stand and raise the hook slightly. To those who have never met with this trouble the first encounter is very apt to prove aggravating.

TELEPHONE PROTECTION.

One of the greatest handicaps experienced by the pioneer in telephone work was the popular belief that the telephone wires would supply a path by which lightning could enter the house, and even now the belief still exists among a great many people that they run great risks in having telephones installed in their homes, says the Electrical Age. In the early days of telephony there was some ground for these beliefs but owing to the protective devices now in general use on telephone systems, and described in this article, the basis for this belief no longer exists.

To the best of my knowledge there has never occurred an instance in which lightning struck a subscriber's wire and thereby gained entrance to his house, one reason for this being found in the fact that a current of such a tremendous pressure as that of a lightning discharge would find a telephone wire far too small to serve as a conductor, the result being that the wire would instantly fuse or melt, thereby cutting off from all danger the house in which the telephone was situated. A small fraction of the discharge, however, might be deflected onto the telephone wire, thus allowing the discharge to enter the house. By the use of a good lightning arrester this is now rendered impossible.

It is very likely, however, that a reader may have noticed strange phenomena occurring in the telephone during a thunder storm, such as loud reports as though an explosion were taking place within the telephone box, crackling sounds, and even flashes of light when the receiver was removed from the hook. In some cases he may even have experienced a severe shock.

These manifestations were rarely caused by the lightning itself, however, but were due to the static induction caused by the same. In order to make this more clear one should imagine the earth to be the outside coating of a Leyden jar; the telephone wires being the inside coating. The two wires of a telephone line would form the same combination. Lightning striking the earth in the vicinity of a telephone would resemble the charging of a Leyden jar. After the charge had acumulated sufficient pressure it would endeavor to find a field through which to discharge itself, and local conditions would probably decide the manner in which this discharge would occur. If the telephone was equipped with a ground-plate, as further on described, the current would jump across the air gap to the ground connection, causing a pistol-like report. Where a carbon block arrester is used the wires are instantly and noiselessly rendered normal. Should the telephone, however, lack any form of lightning arrester whatever, the two sides or legs of the line would tend to evenly balance themselves as regards pressure, the current during this operation flowing back and forth through the telephone. Should a subscriber remove the receiver from the hook while this was going on the circuit would be disturbed, causing the induced current to momentarily arc across the switch contacts, causing the subscriber to receive a distinct shock should he touch any of the metal parts on the telephone.

There have been cases shown where static induction had accumulated to such an extent that it presented all the characteristics of a miniature discharge of lightning—jumping from the telephone to adjacent water-pipes, etc. In some cases fires have been attributed to this cause.

The question of reliable protection from lightning was among the first problems to receive the attention of telephone engineers and the variety of the devices designed and used for that purpose speaks highly for the intelligence and perseverance of those who have brought telephony to its present state of efficiency.

Before going any further, it might be well to mention the various kinds of currents which in practice have to be guarded against.

First, there is the direct discharge of lightning onto the line. This, although apparently the most formidable, was the simplest to dispose of and is now practically safeguarded against by two very simple means—by laying the wires in cables underground, as is done in our large cities, in which case they are not exposed to lightning discharges; and by running a single line of barbwire along the tops of the pole used in overhead construction; said wire being connected to the earth at regular intervals so as to insure a good ground connection. The barbs on this wire collect the lightning and thereby protect the telephone circuits.

Second: We have what is generally termed static induction; that is to say, the presence of atmospheric electricity in the neighborhood of the telephone line will often charge the same to such an extent as to render it unfit for service until the induced charge has been allowed to escape to the ground, and the line rendered normal. This latter is the current that the public is more or less familiar with in the form of shocks, loud reports, etc., and is what is generally supposed to be lightning itself. A case of this kind that the writer recalls was in an exchange in a small western town where most of the lines ran on poles for miles over the prairie. Here the effect of static induction was so pronounced that many of the lines could not be used until they had been grounded and thus discharged; and as grounding

the lines before each conversation was not possible, the manager had the wiring of the subscriber's instrument changed, as per Fig. 2. Here it will be seen that when the receiver is hung up, the two sides of the line B C are short-circuited through the telephone hook, and also connected through contact A to the bell and thence to ground at G. This arrangement leaves the two sides of the line and the ground always connected except during conversation, and hence there was no chance for the line to accumulate unequal potentials. The ringer circuit is through both sides of the line and ground as can be seen in the sketch. This plan was found to be very successful and no further trouble was experienced from that source.

Third, we have what are known as "sneak currents," so termed on account of the fact that they sneak past the fuse and carbon block arrester. These are generally caused by crosses with, or leakage from, lightning or power systems, and may vary from a fraction of an ampere to the full current from the power house. It might not be amiss to mention here that crosses consist of a wire of one system (telephone) falling across wires of another system (electric light, etc.), the result being that the current leaks from one to the other. To these are attributed most of the burn-out troubles of modern telephony.

In describing the different forms of "arresters" or protectors now in general use, we will commence with those used to protect the subscriber and his telephone.

Among the first lightning arresters to come into general use was what is known as a "ground-plate," one form of which is shown in Fig. 1, which consists of three metal plates, A, B, C, usually mounted on the telephone itself. A is connected to the ground, while B and C are connected respectively to the two sides of the line. There is also a

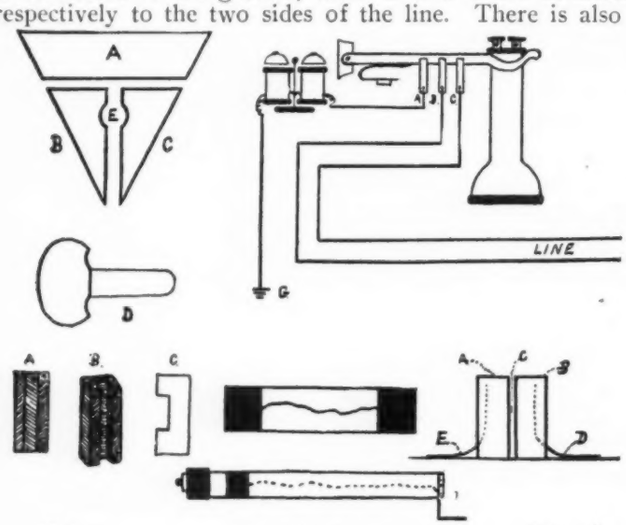


FIG. 1. FIG. 3. FIG. 2.
FIG. 5. FIG. 4. FIG. 6.

ILLUSTRATING TYPES OF APPARATUS EMPLOYED IN PROTECTING TELEPHONE USERS AND OPERATORS.

metal plug D which can be inserted between B and C at the circular opening E, so as to short-circuit the telephone by providing connections between B and C.

The theory of this arrester is that the high potential lightning discharge will leap across the air-gap from B C to the ground connection A, while the low voltage telephone currents will find the air-gap an impossible barrier.

In actual practice, however, this form of arrester was found to leave much to be desired. For instance, the subscriber would forget to remove the plug D from between the plates B C, with the result that the line would be short-circuited and useless, necessitating a trip for the "trouble-man" just to remove the plug. Also the crackling sound of the discharge across the ground plate led the public to believe that the house was in danger from lightning, or in some case caused the removal of an otherwise satisfactory telephone. In addition it was soon discovered that current was often found on the line too weak to jump the air-gap, and yet strong enough to "burn-out" the telephone.

As a substitute for the ground-plate, which was mounted on the telephone itself, the next arrester used was a fuse or pair of fuses set in series with one or both sides of the line, the fuses being gauged to "blow" or melt, at a given amperage in excess of the usual current, such as would be occasioned by a cross or a discharge of lightning.

These fuses are divided into two classes, the plain fuse mounted on mica, and generally held between clips as in Fig. 3, and the enclosed non-arcing type shown in Fig. 4. These latter are found to be the most efficient form, as their length, four and one-half inches, obviates any risk of an arc forming, and being enclosed in a tube as shown, the fused metal is prevented from doing damage.

Both these fuses were found to answer the purpose of opening the line, and thereby protecting the instrument, but it was also found necessary to provide an easy path to the ground for the high voltage current which had been "arrested" by the fuse, as otherwise, it would cause damage to the building. With this end in view, a modification of the old "ground-plate" was designed, which possessed all the merits of the same without having any of its defects. This consisted of two carbon plates *a* and *b*, Fig. 5, and a strip of mica *c*, cut out in the center. These are mounted as shown in Fig. 6, *d* and *e* being two brass springs forming terminals of the line and the ground respectively. It will now be seen that the carbon blocks *a* and *b* are held apart by the mica insulation *c*, but *c*, it will be remembered, is cut away in the center so that there is an air space between *a* and *b* which is equal to the thickness of the mica, usually .008 of an inch. Now the ordinary telephone currents are not capable of jumping this air space, small though it is, but the slightest lightning or other high potential discharge would immediately bridge the air-gap, and continue through to carbon block *b*, to spring *d* and thence to the ground. This combination type of fuse and carbon block arrester was found to absolutely protect the public from any danger from lightning or other heavy current, and is the type of arrester generally in use by the large telephone companies. This type is usually placed where the line enters the building instead of on the telephone itself, as was the case with the old ground-plate type.

The next, and in some ways the most important improvement in protective devices, was that which was designed to take care of the sneak-currents.

These currents are frequently so weak that they will not blow the fuses on the arresters, or even ground themselves through the carbon-blocks, and yet by their continued flow they would, in the course of a short time, do great damage to the telephones and switchboards by heating and charring the insulation on the coils of magnet windings, etc.

The remedy for this class of trouble is generally conceded to have been invented by Mr. H. V. Hayes. The apparatus used consists of what is known as a heat-coil, composed of a coil of German silver or other high resistance wire wound around a fusible plug, which plug holds a spring in a state of tension. When current exceeding a predetermined amperage passes through the coil, it heats the same, and the heat thus generated melts the fusible plug and releases the spring, which either opens or grounds the line as arranged.

This device, which can be set to operate on a fraction of an ampere, has proven itself to be capable of doing all that is desired, and is to be found in one form or another in all good exchanges.

Not long ago a squirrel put eight hundred telephones out of service in a suburb near Boston. The squirrel ran up a tree and gnawed through a lead cable, soon afterward it rained and the entire cable was rendered useless.

*The Relative Merits of Central Energy and Magneto Telephone Systems in Small Exchanges.

There have been a great many statements made regarding these two classes of service, some of which are in favor of one and others in favor of the other system. It is not the purpose of this article to advocate either system but merely to show some of the advantages of each.

There is no doubt that with a large exchange system, the cheapest and most advantageous service may be given with a central energy. It is only where the system is small that any doubt arises as to which is the best.

We will first consider the exchange which is just starting into business. The first problem is to choose between the two systems. Cost will probably be the first consideration. In an exchange where the instruments and switchboard for a magneto system cost twenty-five hundred dollars, the central energy system would cost for the same size, approximately the same where primary batteries are used and fifteen per cent more with storage batteries. The difference would be in the added complexity of the central energy plant in the switchboard. The average employe in an exchange of this size is not competent to hunt out the trouble on such a switchboard, so it is necessary to employ a much better man who will demand a higher salary. The battery question has been argued in favor of central energy. To be sure, the matter of inspection is a considerable item in a local battery system, but in an exchange of two hundred subscribers, one man can take care of the system, so the matter rests entirely on the cost of the batteries. Some form of battery for central energy purposes must be used which possesses a very low internal resistance; such battery is either some form of caustic soda battery or storage cells. If of the former type, there will be required not less than twenty-five cells each of which costs as much as ten dry cells, and their life is as short as that of the latter type. If storage cells are used they must be changed. The charging requires either a charging machine or the reduction of the voltage through a resistance. The charging machine adds to the expense of the exchange and charging through resistance is extremely wasteful. If any other type of battery is used the internal resistance is so great that excessive cross talk is thrown into the system.

The magneto system, taken as a whole, is of course more complicated than the central energy, but as the complication is divided through a large number of telephones, any trouble is not apt to affect the service of the whole exchange. Any battery trouble on a central energy system is liable to throw out the whole system. In order to conserve the primary battery of a central energy system, it is usual to insert a considerable resistance in the circuits. This makes the amount of current for each telephone very small, in fact too small to permit the transmitters to work at their maximum efficiency. If we add to this the resistance of the longer lines, we will find that a certain number of the telephones are giving poor service.

The well designed central energy transmitter will work at its maximum efficiency with a current of fifteen hundredths (.15) ampere and there will not be any very marked decrease in the transmission where the current is reduced to one-half that amount. This gives a permissable line circuit resistance at twenty-four volts of one hundred and sixty ohms or a line of No. 12 iron about two and one-half miles long. Now, where lines are longer or of higher resistance, there is an immediate falling off of the amount of current and consequently of the transmission, so where long country lines are used the central energy system must give way to the magneto.

Taking a two hundred line exchange, there would be four hundred cells of dry battery, costing in the neighborhood of sixty dollars. In the central energy exchange there would be, in order to have twenty volts, thirty-three cells of primary battery of a type fit for central energy work. These cells would be of two hundred and fifty ampere hours' capacity and would cost not less than sixty-five dollars. The dry cells would easily last one year on an average. The central energy cells would last in this exchange where there were five hundred calls a day, each averaging three minutes, not longer than four months, unless the current supplied to the lines was so small that the transmission suffered greatly. There would then be something like one hundred and thirty dollars difference in favor of the dry cells, on a local battery system. With storage cells the expense of maintenance would depend upon the rates charged for current. It would require one man to take care of the exchange in either case, though he would be kept busier in the exchange using the local batteries.

The line work for a central energy system must be of the best and so built that there will be a minimum number of crosses to exhaust the batteries.

The central energy system is a little more convenient where the exchange is very busy, as the operator can take care of a larger number of calls. It is not the usual experience in an exchange of two hundred that the calls cannot be easily taken care of where a magneto system is used.

Where it becomes necessary in a magneto system to have more than one man constantly employed in inspection work, a central energy system then is the most economical, for one man can cover twice the ground in such a system.

From the standpoint of efficient transmission, there is no difference between central energy and magneto systems, provided the lines are not too long. A central energy system can talk with local battery systems without any difficulty and very efficiently.

Another point that presents itself is, how large must an exchange be before it will pay to change from a magneto to a central energy system? That will of course depend upon the condition of the telephone apparatus. Sold as second hand, telephones will hardly bring enough to make it worth while to handle them. It is always possible to rewire a telephone and put in the necessary apparatus and if the instrument is in good condition it is a very good method.

As to the switchboard, it should not be discarded until it has lost its usefulness either because worn out or because it is so slow that it cannot be used successfully. According to general experience, it has been found that if the new board is to be bought and the exchange is to have as many as five hundred subscribers in the near future, it will be advantageous to install a central energy system. It is of course out of the question to put in a central energy exchange of that size unless storage batteries are used. Where these batteries are used it is better to have a source of energy that will never fail. In fact it is much better to have two sources of energy so that one may always be available.

*Paper read by W. A. Taylor, before the Wisconsin Association, Feb. 11 and 12.

THE AUTOBIOGRAPHY OF A CEDAR POLE

FLORETTA G. ELMORE.

"Caw, caw, caw—tinkle, tinkle, gurgle, murmur—swish, swish—sigh!" Then, "chickadee, dee, dee! Why, my dear young friend, good morning! Pray, what do you think of the world?" "Oh," I whispered, wonderingly, "have I come up? And is this the world?"

"As sure as I'm a chickadee and you're a cedar!" answered my friendly visitor. "You're the first arrival seen this spring and I must be off and spread the news. Good-bye for a while. Keep on as you've begun and you'll be as fine and stately as your next-door neighbor!" and with a parting chirp my new-found friend fluttered away, leaving me to find what sort of a place the world was. I remember that eventful day as clearly as though it had been yesterday, though it's years and years since I learned that the "Caw, caw, caw!" was the cry of the crows overhead; that the "tinkle, tinkle, tinkle" was the pretty note of the stream that murmured and gurgled a little way to my left; that the swish and sigh were the soft voices of my comrades as they talked to the wind by day or sang lullabies to sleepy birds at nightfall. The lively chickadee told of my coming far and wide, as he had promised, and soon friendly messages came to me from all the forest. One of my tall neighbors bent his lowest branches toward me protectingly and answered all my questions, shaking his good-natured sides at some of them with quite amusement.

Courtesy of Maltby Lumber Co.
"YOU'RE THE FIRST ARRIVAL SEEN THIS SPRING."

He was a Norway pine, he told me, and could trace his lineage back to hardy ancestors who had seen the Vikings start on their daring voyages and had heard the woods ring with the sound of their axes as they built their long boats, the carriers of death and pillage. Often afterward I was reminded of his wild forefathers and could see that years and change of country had not robbed their descendant of their native spirit; for where the storm raged the fiercest there was he the most exultant, tossing his long arms wildly about and roaring with the north wind that fought us mercilessly. Most of us preferred the balmy days of summer, with their gentle rains or wealth of sunshine, but not so this hardy son of Norway. He wore his winter coat of mail like the ancient sea kings he told of, and his hoary branches hung down like their unkempt locks.

Just a short distance in front of me stood a young spruce, rather disposed to be proud of its shining green branches, but nevertheless friendly and good-humored. After my first conversation with the giant pine I heard this second neighbor call out, to be sure a trifle patronizingly, but still kindly, "Well, young one, is this more pleasant than being underground, with no one but worms and black beetles for company?" To which greeting I replied respectfully, as befitted my age, and then flattered the foolish fellow by asking him to tell me more of the new life I had entered. I learned from him that we should not always stay in this spring-kissed home, but that some time, just when no one knew, men would come with axes and cut down the tallest and straightest of us to be carried away into the world. Once before this had happened in the forest. "But you," laughed the complacent spruce, "you need not expect to be taken for many moons, so be content with your quiet life here." Indeed, no one had to tell me this, for I loved my northern home from the first day I entered it, and even now, old and prosaic as I am grown, think with regret of the time I left it forever. But, thank nature, I have always had a cheerful heart, and though I can't be green in my old age, I certainly shan't grow blue! The next friend I made on my birthday was a motherly balsam, who stood a little to the west of me and from whom I got much sage advice and counsel during our long friendship. She it was who told me not to fear the flocks of "wax wings" who would be my constant guests as soon as my clusters of berries appeared. "For," said she, "they are not cruel, but only possessed of greed and will do no damage which nature will not repair for you cheerfully."

And now do you see how cleverly I have worked around to the space on my right, that little southerly spot of ground, which was to be the most charming to me in the whole forest? This place, on the morning whereof I write, was covered only by a few pine needles; but do not think that I have fired your curiosity to no purpose, for the next day, the second time the sun had shone on me, there peeped up from the earth the daintiest little cedar that ever graced a dim old forest or made a bow to the cordial spring wind. I smile now to think of the thrill that went through my little branches when first I saw this lovely wee green thing, and eagerly welcomed her, telling her with the air of a patriarch all my little store of news.

Courtesy of the Maltby Lumber Co.
"MEN WITH AXES HAVE BEGUN CUTTING."

As the days went by we frolicked together with the jolly breezes, and at night listened with the birds to the same lullaby that hushed us to sleep in "the friendly silence of the quiet moon."

I smile to think of how I bade her have no fear when our first winter came, bringing with it a boisterous crowd of winds and storms that made our little selves tremble and lean toward each other for shelter. But we ceased at last to dread our frost friends, and when five years had passed wore our winter garments as willingly as the valiant Norway pine. Ah! if you could have seen my lovely little cedar when first she decked herself in a glory of purple berries, shaking her branches coyly in the breeze to display her charms still further! There is no doubt that I was

Courtesy of Fowler-Jacobs Co.
"THIS LIFE GROWS A BIT MONOTONOUS."

hopelessly and madly in love; so much so that I even called on the lightning to strike me dead with his swift arrows when she had been more kind than usual to my old acquaintance, the conceited spruce.. But she always relented in the end and would be so friendly and so charming withal that I could do nothing but forgive her and go on loving her more than ever.

So the years went by and we shot up ever nearer to the smiling sky overhead, until we grew so tall that the hastening winds would stop a moment for a little chat and the birds would build in our thick branches with no fear of discovery. One frosty morning in winter I awoke with the feeling that spring must be coming, such a stir seemed to pervade all the forest. But the first words of my neighbor spruce told me I was wrong and excited me not a little. "Well, young one," said he (he had never stopped calling me by that name, although I was full as tall as he now), "well, young one, make the most of your charming companion" (I couldn't help thinking this showed a jealous nature), "for another winter won't see you both here making pretty speeches to each other. Men with axes have begun cutting at the other end of the forest, and, depend upon it, they won't stop till they have us all. Frankly, I'm not sorry, for this life grows a bit monotonous after fifty odd years. Heigho, for the world, say I!"

Perhaps you'll feel with the spruce a mighty contempt for me when I tell you that my first thought on hearing this news was not "Alas, how can I leave the forest, its clinging beauties, its serene loveliness?" but (ah, the witchery of woman!) "Alas, how can I leave my love!"

But, smile though you may, I am borne up by the fact that one person, and he a member of your race, sympathized with me, though unwittingly, it is true, and made my conduct seem both right and reasonable. It was not long after sunrise that I first saw my unknown friend. He came through the forest with a group of woodsmen, and though they were big, sturdy fellows, we saw at a glance that he was easily their superior. It was not that he was so tall, for I have seen many men who would stand above him, but never one with more the air of a gentleman, with more the face of a genuine *man*. He was dressed like the others, in the plain clothes worn in a logging camp, but was nevertheless so prepossessing that I trembled to think what my fate might have been had my sweetheart seen him years before. From the words of the men we knew they were out on a survey of the forest, and I learned afterward that their leader was the representative of some firm in a distant city come to learn all the steps of his business at first hand. When they came to my charming neighbor the man stopped with an exclamation of surprise. "Look here!" he called to the others, "that's as perfect a cedar as you'll find anywhere in the United States. By Jove! see how tall and straight and symmetrical it is! Seems a pity to cut up a thing like that into poles or pencils." "If it's pencils they want," I thought miserably, "my heart will furnish all the lead they need. But I'm thankful he can appreciate she's different from the rest."

After they had passed a chickadee flew by, all in a flutter, telling us the latest news. "Do you remember," said the unfeeling little baggage in great amusement, "that gnarled old hemlock just south of where the brook turns in its course, who has been making love with no success for ten years to a saucy little pine? Well, I wish you might have seen him this morning! He heard the men say that his little dear would be made into matches before long, and he nestles his withered old branches mournfully and sighs like an October wind. 'Matches!' he says, gloomily, 'they little know what a fine match they'll spoil when they take her away!' The little pine laughed the heartiest of all at this, for she's often told him she'd die rather than have any-

Courtesy of Pendleton & Gilkey.
"SEE HOW TALL AND STRAIGHT AND SYMMETRICAL."

thing to do with him. Is there anything more conceited than a *man?*" finished the saucy minx, and flew off, talking so fast we couldn't understand a word of what she said.

"Ha!" exclaimed the old pine I had known so long when our noisy visitor was out of hearing, "so they make matches from us, do they? The luck of my fathers goes with me. What could be better than to end one's life in a thousand fierce blazes and be feared and yet sought for by all mankind? I long for the day when the sharp ax will strike me and I shall fall with a ringing crash."

So the forest talked together all that day and at nightfall the young man came again, this time alone, and walked by

himself for a long time. But he never went far from the lovely cedar he had so admired in the morning, and he would stand and look at it with such an expression that I knew he, too, was in love and that in some way the cedar brought back pleasant memories. "Just such grace," he would say half aloud. "Just as tall and straight and lovely to see!" Every evening this poor young man came again, with only his thoughts for company, and once he went so far as to write some verses by the light of the moon. When he

Courtesy of Fowler-Jacobs Co.
"THANKFUL THE WATERS WERE FROZEN."

had finished he read them half aloud to the listening night, and the only one I remember was something like this:

"Tell me, forest maid, I pray,
Who it was pursued thee
Far to this cold land away?
Who it was that wooed thee?
Like another Daphne, thou
Soughtest shy seclusion.
Are my love and praises now,
Daphne, an intrusion?

Then, rising, he said half ashamed, "Well, little cedar, you've helped a poor love-sick fellow more than you know this winter. What a fool a girl can make of a man!" And, sighing at his folly, the young man left us, too deep in his thoughts to notice when he dropped one of the pages he had written on and which now fluttered to rest among the branches of a little juniper shrub. Unfortunate young man, you little knew the mischief your carelessness made that night! The next morning the cause of our friend's parting words to his favorite cedar were made known to us, for the chickadee told us that a party of visitors had arrived at camp and would spend the day. "And *she's* come," said our messenger, much elated. "She's come, more beautiful than the first flower of spring or the last gorgeous leaf of autumn." "She," you must know, had been much talked of among us, for the young man's moonlight wanderings were known to us all. The excitement caused by this announcement had hardly subsided when we heard voices in the distance, one of which we knew of old, while the other was so singularly clear and sweet that the brook told me afterward it was thankful the waters were frozen so that their poor music could not be compared to hers. But when we saw her—oh! my bark and berries! We forgave the young man all his folly on the spot. Straight and tall she was indeed, with eyes like stars and a mouth as sweet as the voice that came from it. Just as she and her companion drew near us some one called the young man from a distance, and, telling her he would be back in a moment, he hurried off in the direction of the sound. Then, ah, that unlucky juniper! The young lady, left to herself, glanced about her, and straightway her eyes fell on the paper lodged in the shrub. "Poetry!" she exclaimed softly, "and in Roger's writing. Why, what does this mean?" as her eye traveled rapidly over the pages:

"Tell me, forest maid, I pray."

"Are my love and praises now, Daphne, an intrusion?"

"How rude and unkind for him to pretend he cares for me, when all the time he writes love verses to another girl! Of course, it's that pink-cheeked thing who lives with her father on the edge of the woods. She told me to-day it seemed a shame for her to be alone up here. Oh, why didn't he let me know?" In this way the young lady bewailed her fate until Roger came back, when she suddenly became exceedingly composed and cold, would give no hint of the reasons for her behavior and, in short, drove the poor fellow to despair, as girls have a way of doing. Over and over he implored her to tell him what had changed her, but she preserved a stony indifference until he, too, resorted to his dignity, and by his apparent coldness convinced her still more that at heart he was unfaithful. You may imagine what a gloomy effect this had on the forest, and as it happened it was but the forerunner of a still greater separation. For the next day the woodsmen reached us with their sharp axes and laid my long-loved "Daphne" and me low on the ground. Next they stripped me of my branching foliage, even of my very bark, so that I lay naked and shivering in the cold air. In this wretched condition they put me on a sleigh and carried me off a long distance to a landing, where I was put, with many others like myself, onto cars that started off with a shriek and roar and carried us on and on I knew not where. I never saw again the lovely "forest maid," nor the vain spruce, nor any of the rest; and I was filled with thoughts of them during my strange, swift journey. But even more I wondered what the poor young man and the unhappy young lady were doing to console their foolish selves. Finally the cars stopped one morning with a more decided jolt than they had before, and several men came and transferred us to wagons

Courtesy of Pendleton & Gilkey.
"THAT'S AS PERFECT A CEDAR AS YOU'LL FIND."

before we'd got rested from our long journey. Then the drivers climbed to their seats and the horses started off with straining sides, the wheels creaking slowly over the frozen road. My destination was a yard surrounded by a high wooden fence, but though it was very large, it didn't compare with the forest in either size or beauty. Here I lay for some time with thousands of other poles, for this is what we were now called, and I wish I might tell you some of the stories I heard there. There were cedars from all over the country, and most of them had had far more interesting lives than mine. One morning, after I was thoroughly at

home in my new surroundings, two men came up and looked us over, and I heard a familiar voice say, "Send up this lot of poles to fill that last order of the local telephone company. They want them to-day, sure." This news was very welcome, for I had grown tired of my bare surroundings and was anxious for a change. But the voice of the speaker reminded me of past troubles, for although it was Roger talking, the tone had lost its old buoyancy and elation. "Oh, poor young things!" I thought, mournfully, "they still misunderstand each other. I remember at his age I felt just the same when I had quarreled with my sweetheart." I was still turning over such thoughts in my mind when once more I was lifted into a wagon with a great many of my friends and carried through the city. From what the driver said to another man who was with him I knew we were to be telephone poles, and would each be given "a coat of paint" when we were "set up." This was decidedly welcome news, for, as I said before, I was suffering from my stripping in the woods and the air was still cold and frosty. But just what position telephone poles filled no one could tell me, and I took this last trip as ignorant as I had been before of my destination. I soon found, however, that my life was to be an interesting one, for I was put into a deep hole on a busy street (and I must say it was good to be on my feet again), and wires were strung from me to other poles on either side. And let me say now that if any one reading this is afflicted with ennui I advise him to apply at once for my position. There's not a minute of the day of night but some important business or interesting bit of news is coming my way. When I think of how I used to depend on chickadees for everything I heard I am more thankful than ever for city improvements. But I am wandering from the real point of my story, which has, of course, to do with Roger and his offended lady. Try as I would, I could not forget them, and my patience met at last with its reward. One afternoon, three weeks after my arrival (you perceive I use city reckoning now) I had fallen half asleep during a long conversation between a young married couple, when I suddenly felt a thrill go all through me, which I realized was caused by a voice traveling along my wire, a voice whose sweetness and clearness I had heard but once before when I lived in the northern woods with Daphne. "Oh, Roger," said the voice, after some connection had been made, "is this you?" And then, without waiting for an answer, it hurried on: "This—this—well, this is Alice, and I want to tell you that I saw that poem of yours in the paper this morning, and when I saw the title—it says 'To a Cedar'—you know, why, then I realized that I had been all wrong—and—well, that is—won't you come up and let me explain?" "Let you explain?" fairly shouted Roger at the other end, "my dear girl, that's what I've wanted you to do for five months. I haven't the least idea what you mean, but I'll be up there in ten minutes—and Alice—but I'd better wait till I see you to tell you the rest, as some one may be listening."

Some one certainly was listening, drinking in every word with the keenest delight; but I know they never would have been sorry if they could have seen me beam on the world that afternoon. I may be old and ugly, and I know I've outlived my own romance, but I'm not too old to enjoy another's, and so no one could be more glad than I that this has come out so happily—no one, that is, except perhaps Roger and Alice.

DETECTING CROUP BY TELEPHONE.

A resident of Newark, N. J., was awakened at midnight one night this week by his wife, who said their infant son had the croup and he must go for the doctor. There was a telephone in the house and the husband suggested calling the physician by this means. The doctor said: "Are you sure the child has the croup? I have been up most of the last three nights and am tired and do not want to go out. Bring the child to the telephone and let it cough."

The parents did so, and after a moment the baby whimpered and coughed.

Quick as a wink the physician shouted, "That's croup, sure enough." He came and prescribed for the baby.

PRESENT EXTENT OF WIRELESS TELEGRAPHY.

At the present time there are no less than eight companies prepared to build and install "cableless" telegraph apparatus; these are the British Marconi's Wireless Telegraph Company (Limited), the Marconi International Marine Communication Company, the Canadian Marconi Company, the Marconi Company of the United States, the General Electric Company of Berlin, the Siemens & Halske Company, of Berlin; Queen & Co., of Philadelphia, and the De Forest Company, of New York City.

The various Marconi companies have equipped six stations in the United States, including the most powerful one in the world, at South Wellfleet, Mass., their other stations throughout the world are at Table Head, Glace Bay, Nova Scotia; three stations are in course of construction in Alaska; five stations are in operation in Hawaii, while in Great Britain there are twenty stations, including the powerful one at Poldhu; in Germany, there is a Marconi equipment on Borkum Island, with its complementary apparatus on Borkum lightship, one in Belgium and another in France complete their list of land stations.

Of steamships carrying Marconi apparatus, there are eighteen vessels, represented by eight lines. The English Admiralty have land stations at Malta, Gibraltar, Tientsin, Hongkong, and Bermuda, and thirty-two men-of-war have Marconi installations; the Royal Italian Navy has five land stations and twenty ships equipped with the same system, bringing the total number of sets of instruments purchased by this company up to one hundred and seventeen.

In the course of 1902, over fifty stations and vessels were supplied with the Slaby-Arco system by the General Electric Company of Berlin, the countries supplied including Germany, Sweden, Norway, Portugal, and Chile for the marine; in Russia, for the postal telegraph, and in Denmark for lightship purposes. The Braun-Siemens & Halske Company have over thirty installations in active service. The Fessenden interests have equipped several stations for the Weather Bureau, and the De Forest Company has land stations at Coney Island, Staten Island, Chesebrough Building, New York City, and Block Island and Point Judith, Rhode Island; the United States navy has adopted their system, and equipments have been supplied to the United States army and signal corps, Annapolis Academy, and the Washington navy yard, besides several vessels plying between the ports of New York City and Central America. —From "Wireless Telegraphy," by A. Frederick Collins, in the *American Monthly Review of Reviews* for February.

TELEGRAPHY IN PERSIA.

In a communication from the U. S. Consulate at Teheran, Persia, we are informed that the telegraph administration in Persia is farmed by one family; i. e., they pay the government, which owns the lines, a rent of about $30,000 a year. From the excess, they pay the expenses of operation, and the ultimate balance is their own profit. The head of the family is the Mukhder-ed-Dowlah. The telephone lines and operation are in the hands of a company-partnership of Belgians and Russians, which goes by the name of the Societé Anonyme de Chemin de Fers et Tramways en Perse. The Belgian address is No. 4 Rue de Quatre Bras, Brussels, and the Russian address is 87 Boulevard Tcherskoi, Moscow.

Telephony.

AN ILLUSTRATED MONTHLY TELEPHONE JOURNAL

Published by

The TELEPHONY PUBLISHING CO.

H. B. McMEAL, President,
ED J. MOCK, Sec'y and Treas.

301-336 MANHATTAN BUILDING, CHICAGO, ILL.

Telephone Harrison 2951.

OFFICES:

NEW YORK, Morton Building.
LONDON, 2 Exeter St., Strand, London, W. C.

SUBSCRIPTION:

In the United States, Canada and Mexico : : : $1.00 Per Year
Foreign Countries, $2.00

ENTERED AT THE CHICAGO POST OFFICE AS SECOND CLASS MAIL MATTER

CHICAGO, MARCH, 1903.

Table of Contents.

The Evolution of the Telephone Switchboard. Thomas D. Lockwood 143-151
Meeting of the Michigan Independent Telephone Association.. 151
Practical Telephony. P. Kerr Higgins 152-154
Kansas Independent Telephone Meeting 154
Decisions Affecting Telephony. Andrews & Murdock 155-156
A Special Inspection. A. E. Dobbs 156-159
Telephone Protection 159-160
Merits of Central Energy and Magneto Systems. W. A. Taylor. 161
Autobiography of a Cedar Pole. Floretta G. Elmore 162-165
Detecting Croup by Telephone 165
Present Extent of Wireless Telephony 165
Telegraphy in Persia 165
EDITORIAL—
To Act as a Unit 166
The Joy of Working 166-167
Standardizing Apparatus 167
Increase in Wire Mileage per Subscriber 167
Our Message to Practical Workers 167
Digest of Telephone and Kindred Patents. Edward E. Clement 168-173
Wisconsin Independent Telephone Association 174-175
Convention Notes 175-176
The Life of Creosoted Telephone Poles 176
Questions and Answers. J. C. Kelsey 177-180
Central Missouri Telephone Association Meeting 180
Our New Pavement 180
Automatic Telephone Operator. William J. Hammer 181-188
The Necessity of Uniformity. A. L. Hutchinson 189-190
A Woman at the Telephone. A. H. E 190
A Group of Prominent Independent Telephone Men 191
MANUFACTURERS' SECTION—
International Telephone Parts 192-193
Trade Notes 194-195
Only Tie Wire Former 195
Frank B. Cook, Chicago 196
Acme Electric Company Philosophy 196-197
New Fire Alarm Equipment 197
A Blow to Letter Writing 197
Joint Transmission 197
Machine Telephone Operating. Joseph B. Baker 198-201
Generators. Charles W. Farr 201
Correspondence Department 202

TO ACT AS A UNIT.

The two factors most essential to the successful growth of the Independent telephone movement are unity of purpose and a thorough knowledge of its aims and its needs. The man of the hour is he whose sane and logical utterances will impel Independents to act as a unit in all that endangers or affects the welfare of the movement as a whole; the man whose intelligent suggestions will lead to a proper understanding of the responsibilities that rest upon every Independent, and how best to discharge these duties; the man who can clearly portray all the conditions that may tend to enrich or to impoverish the material welfare of the Independent movement; the man who can lead the leaders to perceive that they who best comprehend these conditions can bring about a consummation worthy to control, and awaken thoughts and suggestions that may lead to active and hearty co-operation of many who thus far have held aloof from association meetings; the man whose personal magnetism will draw thousands to perceive how irresistible is the power of a movement wherein all its members act as a unit in all that strengthens and enriches the movement as a whole.

THE JOY OF WORKING.

Probably not many of the telephone users in Independent exchanges have given thought to the tremendous advances made in this field in the past few years or have turned their minds to a consideration of the steady, never ceasing effort to constantly improve and invent that which will better and quicken the service they receive. Under the caption, "The Joy of Working," our contemporary, Judicious Advertising, publishes the following:

Think not, Sir Man-of-Leisure, as you peep lazily through your heavily curtained window at the scurrying seven-o'clock crowd on the way to its daily toil, that you have the best of it because you can snuggle back beneath your luxurious covering and sleep until Jeems or Meadows brings your morning coffee and paper and asks if you prefer the Yellow Dragon to the Green Devil for your forenoon spin.

Do not lay the flattering unction to your soul that yours is the happier lot.

Yonder youth with swinging step, with fists dug deep into the pockets of his threadbare coat and a cold luncheon wrapped in paper tucked beneath his arm, tastes a finer, sweeter joy than all your luxury can bring.

His is the pleasure of incentive—the glory of work.

For there is a zest to it all. The quick spring from the bed at the alarm clock's summons, the hastily swallowed breakfast, then out into the wine-like air of early morning. To work—vigorous work of brain and brawn, whether it be pegging away at a desk or directing clanking machinery.

It is occupation—accomplishment!

Do not pity these work-a-day folk. Save your commiseration for the hapless and hopeless idle fellows—the unfortunates or unwillings, alike pitiable.

Joy goes with the working masses. There is joy in the noonday luncheon, whether in a gilded cafe or a cold snack hastily devoured "before the whistle blows."

The evening meal is a feast to the weary man, and his well earned rest is the greatest joy of all.

Hard work is the best of all cures for insomnia.

Thank God you can work!

Though your office labor strains your nerves and racks your brain, though the "shop" takes the best of your strength and vitality—be glad to be living, an active part of the working world.

You must earn your amusements before you can enjoy them. Ennui has no part in the strenuous life.

Be glad, for conscience's sake, that you are not one of those most miserable of all men, a fellow without a job—a human machine standing idle, rusting and losing its value from disuse.

Thank God you can work!

When sorrow and grief come, when you seek to forget, to crush out cruel thoughts, thank God that you can absorb yourself in your occupation, plunge deep into the details of your duty.

Thank God that you can work—that you can grasp your pay envelope and say, "This is mine, the rightful pay for the labor of my brain, the just earnings of my strong right arm."

Be thankful, Employer as well as Employe, for the joy of working.

You know the pleasure of it.

Do not deceive yourself by the promise (which nine times out of ten is a pleasant little fiction) that by-and-by you will retire, ease up, and end your life in idle luxury.

The business game is not alone for the pleasure of the spoils but for the joy of playing it.

What the world may call greed and avarice you know to be the fascination of success—the intoxication of accomplishment; and it will keep you untiringly at it till the end of life.

For life is work.

And work is life.

Like unto Sir Man-of-Leisure has been our great competitor and like him it has awakened to find that the Independent movement is not a "machine standing idle, rusting and losing its value from disuse," but a strong, earnest, thoughtful body of men thoroughly appreciating "the joy of working."

STANDARDIZING APPARATUS.

Some one has advocated a standardization of Independent apparatus. If such were possible, it would be wrong at this stage of telephone progress. For standardization means a dead standstill, a stoppage in the competition of brains. And in these days of crudity in telephone matters, a standstill would mean not only degeneration, but a deadly insult to the business intelligence of the public.

Western Union methods will not do in the telephone business. This company still uses apparatus of civil war times. Could the telephone interests dream of using the present apparatus even ten years from now? There is a movement on foot in the ranks of the Bell interests to concentrate the various engineering departments of the licensee companies into one great department at Boston, and to put a few overcultured men in charge, to rob the individual of the use of his talent, by doing all the thinking of the entire company. What does this mean? It means standardization. It means degeneration. The case of the ostrich with his head hidden, thinking his whole body is safe, will apply, for Boston is a poor place to observe the advance of the telephone movement.

ICNREASE IN WIRE MILEAGE PER SUBSCRIBER.

Puzzling as it may appear to persons unfamiliar with the subject and to telephone men who have not taken the time to reason out the solution to the problem, there is a marked increase in wire mileage per subscriber as the number of subscribers increase, and in pole line mileage, too, but to a far lesser extent. Especially is this increase noticeable where prospective growth leads to a displacement of ground with metallic circuits, as is now happening in many towns. Such changes involve an increase in wire milease of about 100 per cent per subscriber. But nearly as large an increase in mileage may be found in many cities where metallic circuits have long been in service.

According to the tabulations appearing in the annual reports issued by the parent Bell company, the amount of exchange wire in service per subscriber, in 1882, was about seven-tenths of a mile; five years later each subscriber required an average of a mile of wire; in 1893 a mile and a half was the average mileage required per subscriber; while in 1902 a full mile more of wire per subscriber was required on an average than was used in 1882. This phase of inincreased cost coincident with increase in the number of subscribers, appears more in detail in the following table, which shows the total mileage in exchange wires only employed by all Bell subscribers throughout the United States, which brings the average per subscriber far below what it is in many cities. For instance, the average subscriber circuit in one city exceeds six and one-half miles, while another company reports "a growth of 332 per cent in number of subscribers and of 513 per cent in miles of wiring since 1895."

Dec. 31.	Exchange wire Total miles.	Total Stations.	Wire per Station.
1882	68,571	97,728	0.70
1883	85,896	123,625	.69
1884	101,592	134,847	.75
1885	114,046	137,750	.83
1886	128,231	147,068	.87
1887	146,438	158,712	.92
1888	170,471	171,454	.99
1889	193,213	185,003	1.04
1890	240,412	202,931	1.18
1891	266,456	216,017	1.23
1892	307,791	232,140	1.32
1893	353,480	237,186	1.49
1894	396,674	243,432	1.63
1895	459,728	281,695	1.63
1896	536,845	325,244	1.65
1897	626,400	384,230	1.64
1898	772,989	465,180	1,66
1899	1,016,777	632,946	1.61
1900	1,354,202	800,880	1.69
1901	1,729,019	1,020,647	1.69

OUR MESSAGE TO PRACTICAL WORKERS.

How few hoard gold. How many enrich themselves by letting their gold serve others. How many hoard experience until it is valueless. How few place it on the printed page where it returns an interest that hath not wings, though it flies to the four corners of the earth. For unto him who knows that he knows what he should know, and who shares the best that his experience has taught, shall greater knowledge come.

Golden opportunities cannot be hoarded away to be drawn on as we will. Never more opportune the moment than now to portray the practical precepts so profitable in everyday practice. For ever-present with Independents is the right season, and ever-ripe for sowing the seeds of practical knowledge is the field of Independent telephony.

Surely Independents have no desire to sow silence and reap sorrow, because their opponents preferred that plan. For unto every intelligent Independent the thought must appeal that just to that degree in which intercommunion and interchange of thought and knowledge and experience prevail among earnest Independents, will the measure of success of the movement as a whole be marked.

Many Independents there be whose strongest need is the will power to betray that which sound business judgment urgeth to utterance. As the child's speech is often wiser than the child, so rich in practical worth may be the message from the fledgeling in the telephone field. Messages have come from junior workers that fired the ambitious zeal of many an earnest toiler into successful achievement. And to senior dawdlers messages have been returned with suggestions to fire into the devouring flames that which could only prove detrimental to others. For there be those whose words are as the water in the old mill race, rich in quantity, but poor in energy evolved.

We believe that the riches that abound in practical everyday experience in the Independent field can best be crystallized into precious nuggets by those in whom desire and zeal are energized by the longing to achieve a financial as well as a practical success in this their chosen profession. And unto such we gladly open our pages and send this message: Many a fine writer may transmit theory in flowing phrases. But only the inspired toiler familiar with every detail can transmute the practical results and experiences that teach and qualify and characterize into the knowledge that financiers stand ready to capitalize.

DIGEST OF TELEPHONE AND KINDRED PATENTS

Conducted by EDWARD E. CLEMENT.

JANUARY 20, 1903.

No. 718,660—Thomas E. Scantlin, thermal electric cut-out.

The invention in this case is a sneak current arrester. Such devices are universally used for protecting coils and other portions of telephone equipments from the effects of stray currents, usually of too low a voltage or having wrong characteristics, to be carried off by the spark gap arresters. Thus, continuous currents from incandescent light circuits and the like, if accidentally thrown on to a telephone line would heat up and gradually char the insulation on coils, but would not be carried off by the ordinary lightning arresters unless the air gaps were very small and an arc were first sprung by some other agency. In providing protection against such currents telephone companies, both Bell and Independent, have widely employed the so-called "heat

Fig. 1

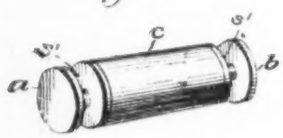
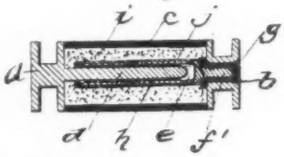


Fig. 2



718,660—THERMAL ELECTRIC CUT-OUT.

coil" devices, which have formed the subject of patents to Frank Cook, F. R. McBerty, Chas. E. Scribner and others. Their devices have consisted of separable parts mechanically connected by a fusible material like solder, and electrically connected through a resistance coil in close proximity to the solder. A sneak current, passing through this coil for a given length of time melts the solder, the separable parts separate, and the circuit is opened.

In the present case Mr. Scantlin provides the separable part *a* and *b*, having stems *d* and *c*, united by solder *h*, but instead of surrounding the soldered portion with a coil, he uses granulated material like German silver or carbon confined within a tube *c*. The carbon is shown at *i* in Fig. 2. and as the stem *c* is insulated from the cap *b* by the bushing *g*, the course of the current is from line to cap *a*, through the carbon *i* to cap *b*, and to the instrument or cross-connecting board. An undue access of current through the carbon for any considerable interval heats it up and melts the solder. An advantage in the use of carbon is that after the heating effect is once started the action should be very rapid, on account of the progressive reduction in the resistance of the carbon due to the heat.

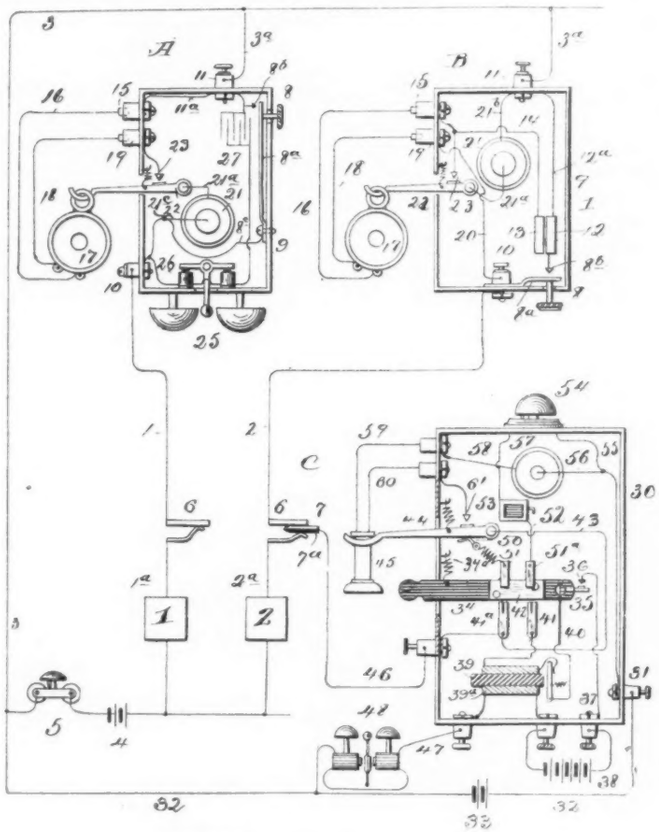
Several other forms of the device are shown in the patent.

718,686—F. B. Wood, telephone system.

This is an intercommunicating system for house or factory, and may be installed on the same wiring as an old-fashioned annunciator system, without change. A, B, etc., are sub-stations, each having a line wire, 1, 2, etc., extending to a central point, and there each line wire passes through the line annunciator 1, 2, etc. A common return 3, with the usual alarm bell 5 and battery 4, serves all the stations. In addition to the drop, a jack 6 is included in each line, by which the central attendant can make connection with the line. For this purpose the central set C is provided with a plug 7, having a single conductor cord 46 connected to binding post on the box 30, which contains the telephone outfit. This includes transmitter 57, ordinary switchhook 44, calling switch 34, receiver 45, bell 54 and calling induction coil 39.

At each sub-station the apparatus includes a transmitter 21, and receiver 17, adapted to be cut into the line 1 or 2 by the switchhook, a pushbutton 8*a*, and a signal for receiving calls. At station A this consists of a magneto bell 25, bridged across the binding posts 10 and 11, with a condenser 27. If short circuiting of the talking currents is to be avoided, this bell would obviously have to be high wound. At station B the receiver 17 is normally in the line, across the posts 10-11, with a spark gap 12-13 interposed.

In operation, the sub-stations call by pressing buttons 8*a*, to throw drops 1, 2, etc., by current from battery 4 in the usual way. To answer a call the central attendant inserts plug 7 and takes down his receiver 45.



718,686—TELEPHONE SYSTEM.

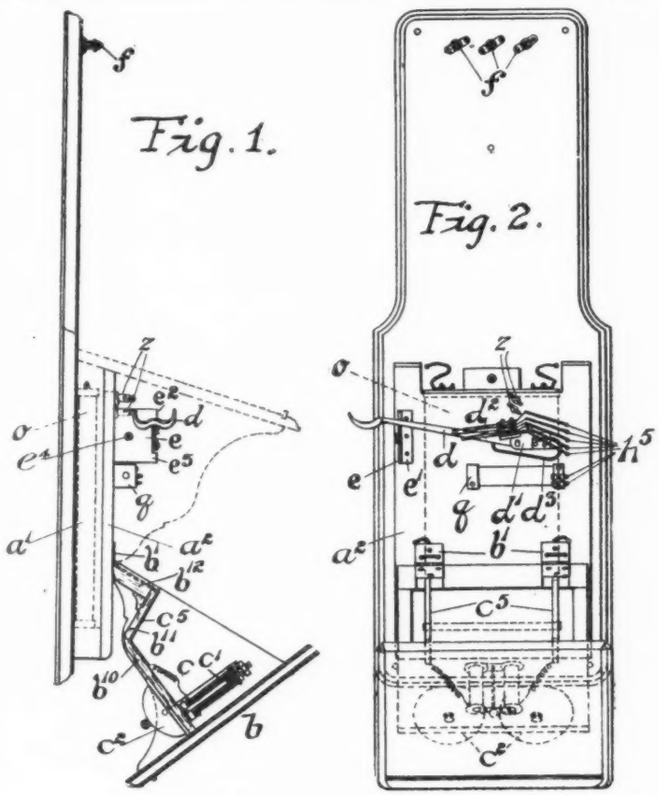
To call out to a sub-station, the attendant inserts plug 7 as before, and pulls down the switch 34. This closes a circuit from cord 46 to the switch contacts 41*a*, 42, 41, to the secondary coil 39*a*, through bell 48 and to common return 32. At the same time the primary circuit of the induction coil is closed from battery 38 to the primary of the coil, wire 40, contacts 35-36, and wire 37 to battery. Induced intermittent currents are thrown on the line, and either operate the bell 25, as at station A, or pass through the receiver 17, as at station B, producing a hum therein.

Should the operator carelessly leave the plug in a jack, a sub-station could still call in by pressing the button 8, circuit then being by way of battery 33 and wire 32 to the

post 31 to bell 54 and drop 52 to switch contacts 51*a*, 42, 51, hook 44, wire 43 and to the cord 46.

718,855—K. B. Miller, telephone set.

This is a wall set for exchange subscribers, particularly designed for common battery systems. The main object of the invention is to mount substantially all the apparatus upon the backboard of the instrument, so that the wiring



718,855—TELEPHONE SET.

and the several parts such as the hook-switch, induction coil, etc., may all be compactly and conveniently placed thereon and secured in position with all joints soldered and all parts adjusted before the usual cover or enclosing case is applied, whereby the manufacture of substantially the whole device is unhampered by adjacent parts of the set, the difficulty of securing and connecting up parts in the interior of a box-like cover or case is avoided, and the labor and expense of obtaining and maintaining the proper adjustment of the devices, where they are separately mounted upon relatively movable parts is entirely dispensed with. The set is being put on the market by the Kellogg Switchboard & Supply Co.

In the drawing herewith, Fig. 1 is a side view, and Fig. 2 a front view of the usual form of the outfit, without the transmitter and arm. On the backboard are mounted the line posts *f*, the condenser box *a2*, and the hinged desk box *b*. In box *a2* the condenser *a'* is housed, and upon the front of the box the switchhook *d* with its contacts and connections, and the induction coil *q*, are mounted. Under the desk and within the front wall *b10* thereof the ringer coils *c* are housed, while the gongs are outside on the front wall *b10*, and under the overhang of the desk. The circuit of the ringer is completed through the hinges *b'*. All wiring from the posts *f* is on the back of the board, in grooves, the wires coming through to the front where the connections are to be made. The condenser box has substantial side and bottom pieces, giving strength and stability to the structure. One-half the switchhook escutcheon is mounted on the box front at *c-c'*, and the other half on the desk box, so that they co-operate to enclose the hook within a slot when the desk is in position.

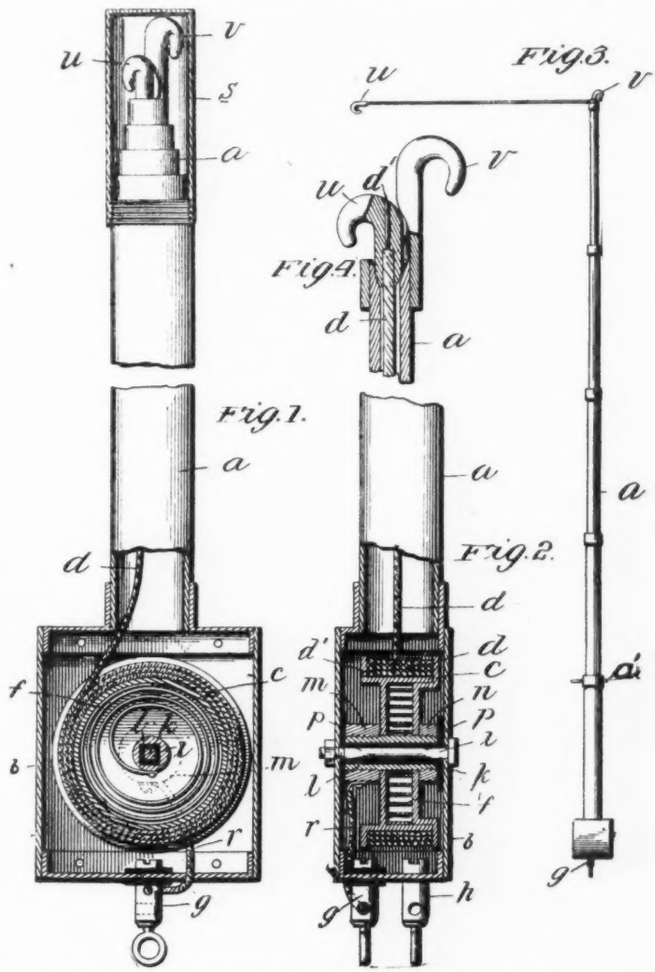
The claims are twenty-four in number and seem to cover most of the details.

JANUARY 27.

719,095—C. Dietz, line tapping device for telegraph or telephone circuits.

This is a telescopic pole carrying conductors so arranged that a person can reach overhead to a considerable height and bridge his instrument across a metallic circuit whose members are spaced apart. The same pole may be used in conjunction with a single wire circuit if desired.

In the figures herewith Fig. 1 shows the pole out of use, with a cap covering the terminals and keeping the telescope sections *a* closed. Fig. 2 is a sectional view at right angles to Fig. 1, and Fig. 3 shows the pole extended and in use. In these figures *a-a* are hollow telescoping sections, the upper or smallest one having a fixed contact hook V. At the bottom end of the pole is a box *b*, containing an insulated reel, on which is wound a cord conductor *d*, whose end passes up through the hollow sections to the top and terminates in a hook *u*, forming a companion to V. The cord



719,095—LINE TAPPING DEVICE FOR TELEPHONE CIRCUITS.

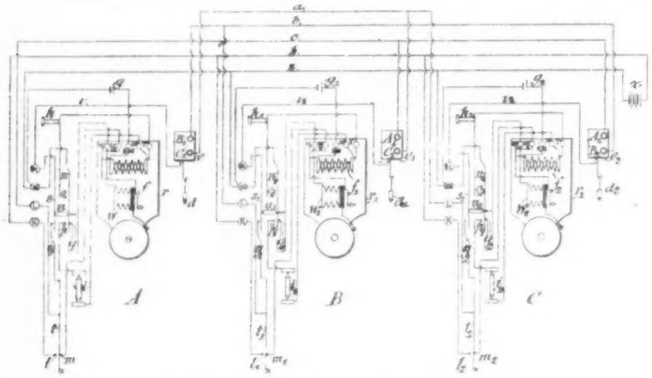
from the reel passes to an insulated post *g*, and the lower section itself has an uninsulated post *h*. The instrument in connected across the posts *g* and *h*. When it is desired to connect with a line overhead, as from a stalled railway car, the pole is opened to the desired length, the instrument connected to the post *g* and *h*, the hook *u*, is caught on one wire of the circuit, as shown in Fig. 3, and the pole moved over until the fixed hook V can be caught on the other wire,

the cord *d* pulling out of the end as the pole is moved over. When the communication is finished the hook V is removed, the pole is reversely moved to remove hook *u*, and the whole pole is again telescoped together, the cord winding up automatically on the reel. The cap *s* is then screwed on, and the whole is in compact portable shape.

In practice and after some wear the contacts of the telescoping sections with each other, as well as those of the hooks with the line wires, would probably be poor, but in temporary or emergency use they would probably be better than none. A better arrangement from a designer's standpoint would be to run cords from both hooks into the basement of the pole.

719,219—W. Höhne, telephone system.

This is an intercommunicating system having for its principal feature the provision of means to prevent calling up or talking through station apparatus that has been left connected after a connection. In the figure, A, B, and C are three stations, each having an individual wire, *a*, *b*, or *c*, as usual, extending to all the other stations. The stations have jack boxes with jacks A′, B′, and C′, and each has a plug *d* whereby connection may be had at any station with the lines of the others. Battery wires *k* and *z* pass from the common calling battery *x*, to all the stations. The main



719,219—TELEPHONE SYSTEM.

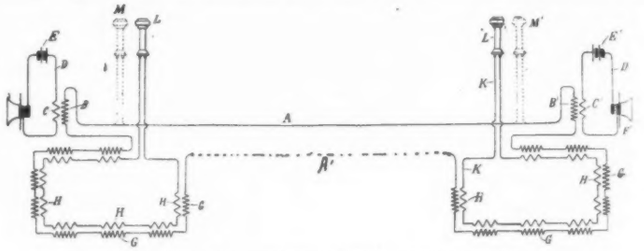
feature referred to lies in the connection of the plug *d* in each case to a normally open switch *s*, so that if the plug is carelessely left in a jack after conversation, the other party is not embarrased in subsequent calls.

If A calls C, the circuit is as follows: (plug *d* being in the jack C′, and springs *t* and *s*, pushed to the left) battery *x*, wire *k*, terminal K at A, switch *t*, contact *y*, switch *s*, terminal *st*, wire *v*, plug *d*, jack C′, line wire *a*, terminal L at station C, switch *t2*, contact *m2*, terminal W″, bell W2, terminal W′, contact *q2*, switch *n2*, termnial ZE, and wire *z* back to battery *x*. After calling thus, C answers in the same way, and signalling switch *t* is released but the switch springs *n* and *s* maintained to the left, and conversation is carried on. When through the springs are released, and it is thereafter impossible to either talk or signal from C to A or vice versa except intentionally.

FEBRUARY 3.

719,432—C. G. Burke, telephonic apparatus.

This patentee is the same who recently received other patents covering systems wherein a metallic circuit of one wire only was employed. In the present case the circuit may consist of either one wire A, or there may be a metallic return as indicated at A′. The gist of the invention lies in providing a number of induction coils with their secondaries G in the line, and a receiver L in circuit with their primaries H. The secondaries are wound with many turns of fine wire, and the primaries with few turns of coarse wire. The inventor claims that the greater the number of coils, the more remarkable the results. The speech transmitted from the instrument F′ at one end of the line to the receiver L at the other is supposed to be reproduced with much greater distinctness and volume than in the receiver M



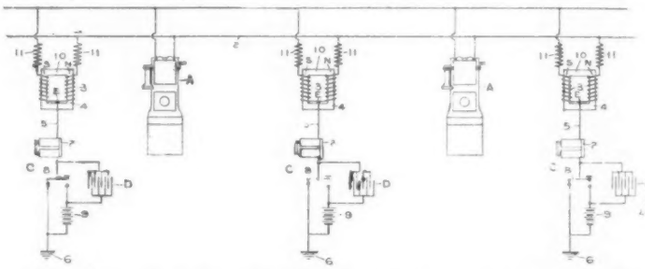
719,432—TELEPHONIC APPARATUS.

included directly in the line. Both receivers M and L are used if desired.

719,458—C. H. Gaunt, combined telegraph and telephone system.

This is a superposed current system wherein the line conductors 2 serve as a metallic circuit for the telephone instruments A-A, and as a single conductor for telegraph instruments C-C-C. The telephone instruments are bridged in the ordinary way, but it is desired to connect the telegraph instruments so that not only will the same potential be maintained on both line wires, but the charging and discharging of the line in transmitting telegraphically will be gradual so that no clicks will be heard in the telephones. This is supposed to be attained by the rather odd expedient of bridging ohmic resistance across the line, and tapping its middle point to ground through an impedance coil. The ohmic resistance is supposed to prevent short-circuiting of the telephone currents, and the impedance to produce a lag in the charge and discharge of the line.

At each telegraph station shown at C in the figure, E is a differentially wound impedance coil having a continuous core 10, and having the two ends of its windings connected to the wires 2, through the ohmic resistances 11, which serve partly to balance potentials. From the point E the ground wire 5 leads through the relay 7 to the key 8 and to ground at 6. A battery 9 sends current to line when the key 8 is depressed, and the well-known condenser D



719,458—COMBINED TELEGRAPH AND TELEPHONE SYSTEM.

may be connected around the key to take up the spark. With this arrangement each impulse from battery 9 magnetizes the core 10, producing a choking effect. Obviously, however, the windings of the coil are neutral to telephone currents.

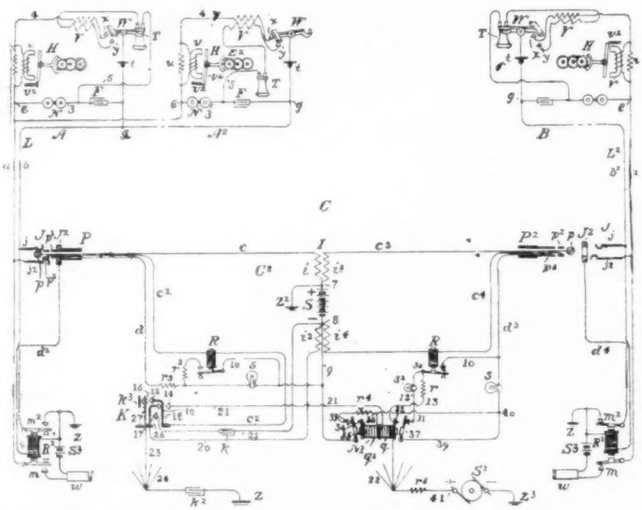
719,736—A. M. Bullard and L. A. Falk, service meter system and apparatus for telephone exchanges.

This is an arrangement whereby toll counters may be located at subscriber's station and operated from central.

The figure shows a common battery system of the well-known relay type employed by the Bell Telephone Co. Subscribers' stations are shown at A, A2 (on a party-line) and at B (on a single line). At these stations the ringers N3 are normally bridged across the line through con-

denser F, and the switch-hook W is adapted to bridge the telephone set T-*t* for conversation. In one side of the talking circuit, thus closed, is connected the register magnet *v*, with a non-inductive shunt *u* to permit the voice currents to pass without substantial retardation. This magnet controls an armature normally biased as shown by a spring *v2*, so as to be unresponsive to the current from the main battery employed for calling in and talking. A reverse current, if strong enough, will operate the register, however.

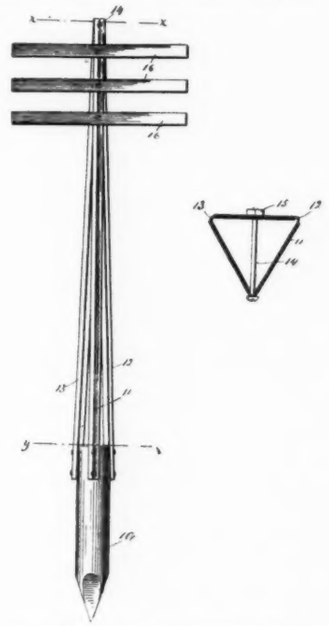
At the central office the line goes to its jacks and cut-off relay as usual, and the regular common-battery cord circuits are provided, with some additions. Plugs P and P2 are connected by cord circuits *c*, *c2*, *c3*, *c4*, through repeating coil I, split to take in battery S. In conductor *c2* is the relay R, controlling a shunt around the supervisory lamp *s*, whose circuit is closed through the plug and jack sleeve J2 to the cut-off relay and ground. The flow of current in the cord conductors *c* and *c2*, controlled by the switch at sub-station A or A2, controls the lamp *s*, therefore, a similar relay is provided in cord *c4*, controlling the lamp *s* on its side, through the shunt 10, which, however, is divided at point 30, one branch including resistance *r*, and the other the signal lamp *s2*, and one or the other of these being brought into the shunt 10, according to the position of the armature 37 of a relay M, which is under the control of the operator. In the cord conductor *c2* is included a switch K, which normally leaves the conductor continuous, but when its button *k3* is depressed by the operator breaks the conductor *c2*, disconnecting it from the cord battery S and connecting the plug end to a generator of reversed and more powerful current, S2, through the spring 18, the wire 21, and one coil *q* of the magnet M. The operation is as follows: Subscriber A calls by taking down his receiver and current flows from battery S to line. The plug P is inserted and the number wanted is connected by plug P2. The operator then waits to see if this subscriber answers before registering. The lamp *s* on the right continues to burn until he does answer, and the lamp *s2* remains dark. When he answers the armature of relay R pulls up and lamp *s* becomes dark because it is shunted by lamp *s2*, of lower resistance, which thereupon lights and signals the operator that it is now in order to press the button. The button *k3* is thereupon depressed, and the generator S is disconnected from line *a-b*, the generator S2 being connected in its place. Current from this generator flows through the magnet windings *v* of the register, in a direction to energize the magnet, and the register records the call. The key K is then permitted to assume a normal condition, and the talking circuit is established through from station to station. Condenser shunts through *k* and *k2* are provided to lessen the harsh noises caused in the subscribers' receivers by the operation of the registering key.



719,736—SERVICE METER SYSTEM FOR TELEPHONE EXCHANGE.

719,841—W. J. McCarthy, telegraph pole.

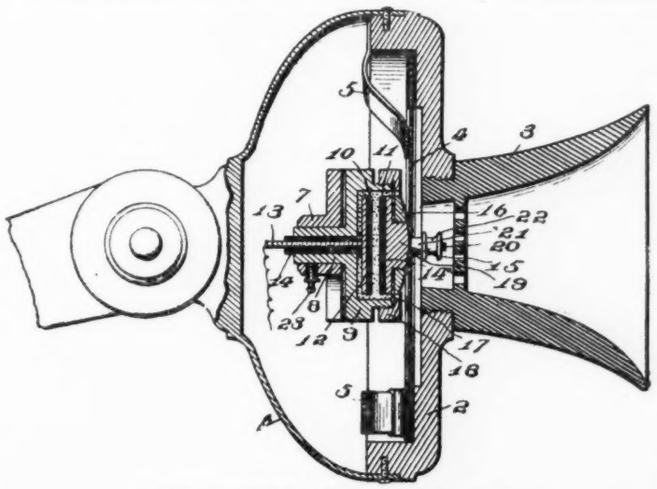
This is a pole made of angle irons, with a wooden butt, and cross-arms of any desired material. In the figure the butt is marked 10, and the angle iron members 11, 12, 13. These are laid on the butt with their angles out, and spiked to it by single spikes as shown. At the upper end the angles are brought together, and their sides fitted into each other to form an equilateral triangle, as shown in the smaller figure to the right. A single bolt 14 is then sufficient to hold all three in place and solidly together. Cross arms 16 are bolted to one or two of the angles, as desired.



719,841—TELEPHONE POLE.

719,972—J. A. Wotton, telephone transmitter.

This is another modification of the White solid back granular transmitter, which has come into use in various forms by many Independent manufacturers. In the White instrument the electrodes are held in a cup, the rear electrode being solidly mounted in the cup and electrically connected therewith, while the front electrode is carried on an auxiliary diaphragm of mica, clamped to the front edge of the

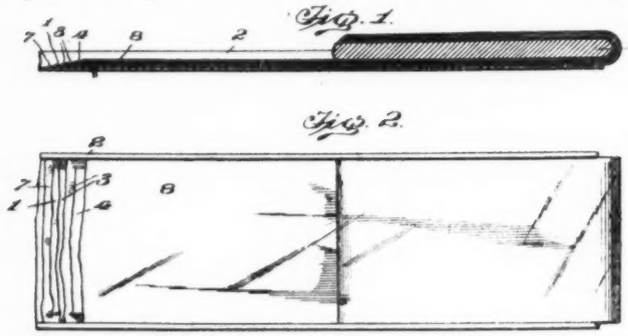


719,972—TELEPHONE TRANSMITTER.

cup. My Wotton makes his auxiliary diaphragm 17 of metal, so that it not only carries the movable electrode 15, but it also connects the electrode electrically with the cup 9. It therefore becomes necessary to insulate the fixed electrode 12, which he does by means of the bushing 14 through the stem of the cup.

719,973—J. A. Wotton, process of manufacturing electric condensers.

This is a process having for its object to avoid the necessity for baking to drive off the moisture in condenser paper.



719,973—PROCESS OF MANUFACTURING ELECTRIC CONDENSERS.

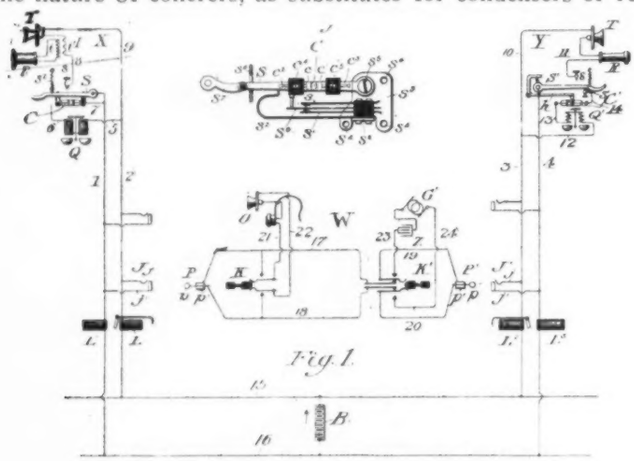
Mr. Wotton boils his condensers instead, and says he can get the same results in one-fifth the time, and with much less expense.

The strips of paper 8 and tinfoil 4 are laid in or through a guide trough, and rolled on a mandrel 5, being secured thereon by strings or otherwise. Each roll is then placed in a vessel of paraffine which has been kept at a temperature of say 250° for a long enough time to drive all the water and most of the air out. The temperature is maintained as long as the rolls are in the bath, the paraffine really being continuously boiled. The effect is to drive the moisture and air from the paper in much less time than by baking. After boiling, the rolls are pressed and cased in the usual way.

FEBRUARY 10.

719,998—E. E. Clement, telephone system.

This invention contemplates the use of novel agencies in the nature of coherers, as substitutes for condensers or relays in many forms of systems. In the system illustrated, the usual condenser employed as a subscriber's station in a common battery telephone system is replaced by a coherer in circuit with the bell. To direct currents from the main battery the bell circuits present individual resistances of great magnitude, say one hundred thousand ohms; while for the ordinary ringing currents they present only the resistance of the bell plus a non-inductive resistance of about forty or fifty ohms.

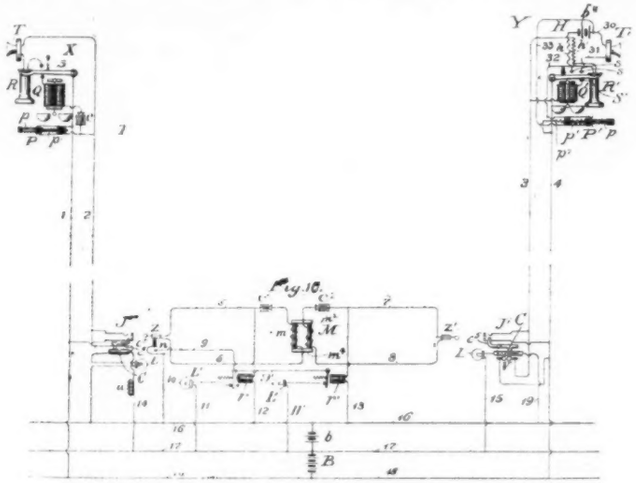


719,998—TELEPHONE SYSTEM.

There are thirty-four claims in the patent, covering all possible applications of the coherer to tangible circuits, and use with tangible currents.

719,999—E. E. Clement, signalling apparatus and system.

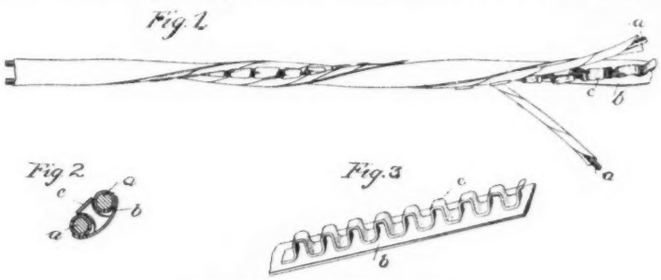
This is a companion patent to the previous one, illustrating and describing many other uses of the coherer in telegraphic and telephonic work, and particularly as performing the functions of relays, either to work sounders in telegraph lines, or at central, as at C in the figure, in a telephone exchange system, to control the line signals L-L. The claims in both patents are basic. The systems, as applied to telephony, enable the expense of condensers to be avoided, without using grounds, in full metallic common battery systems.



719,999—SIGNALING APPARATUS AND SYSTEM.

720,023—R. F. Hall, electric cable.

This invention relates to electric cables in which the conductors are made up in pairs, the two wires of a pair forming the two sides of a metallic circuit and being symmetrically disposed with respect to each other and to other circuits for the purpose of eliminating inductive disturbances like cross talk when used in telephony. In such cables, when used for long distance or toll lines the conductors are of considerable size, ranging from No. 16 to as large a wire as No. 9, copper wire. The object of the invention is to mechanically hold the wires of each pair as far separated as is consistent with keeping the size of the core of the cable within proper compass, while at the same time providing all the air space possible—that is to say, as a general proposition, the greater the amount of air space between the wires of a pair the better, since air has a lower specific inductive capacity than any solid material but some solid insulating material must be interposed to securely hold the wires of the different strands at a uniform distance apart in order that the required symmetrical relation



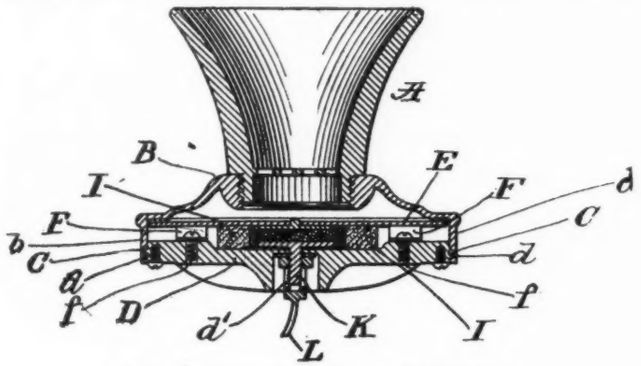
720,023—ELECTRIC CABLE.

as to position may be maintained with respect to the wires of each pair with each other and with other circuits of the same cable or outside circuits within inductive influence. Various plans have been proposed for this, but most have failed, and the old way of simply twisting the wires together with paper solidly wrapped around them is still generally used. More compact cables can be produced this way, and without reflection this seems the main end to be reached. Mature thought reveals possibilities, however, not to be reached in this way.

According to the present invention, a pair of wires, while being twisted, have combined with them a strip of specially prepared paper formed of two portions. One part of the paper is a strip of some width, *b,* termed the "backing." To one side of this is attached another strip *c,* which is gathered in folds or crimped. The strip forming the backing prevents the displacement of the two wires, while the crimped or looped strip attached thereto presents its edges between the two wires of the pair to maintain the wires at a uniform distance apart as shown in Figure 1. The two wires being twisted together will lie along on each side of the edges of the loops, and the backing will form a trough, the wires being thus securely retained in a definite and uniform relation with one another, while leaving a large amount of air insulation between them.

720,085—F. S. Tucker, telephone transmitter.

This is a granular transmitter having a front plate or body B, with a flange *b,* in which is formed an internal annular groove C. The usual mouthpiece A is provided, and a diaphragm E inside the front plate. A bridge D has its ends formed with tenons or projections *d,* to fit in the annular groove or mortise C, one end being inserted first, and the other passed through a notch, not shown in the figure, and turned around to lock. The fixed electrode K is secured directly to the face of the bridge D, having a conductor L attached to its tail by a cap nut terminal as shown. Around this electrode is a soft fiber ring I, enclosing a space filled with granular carbon, and a front electrode carried on the diaphragm E rests on the carbon mass, the



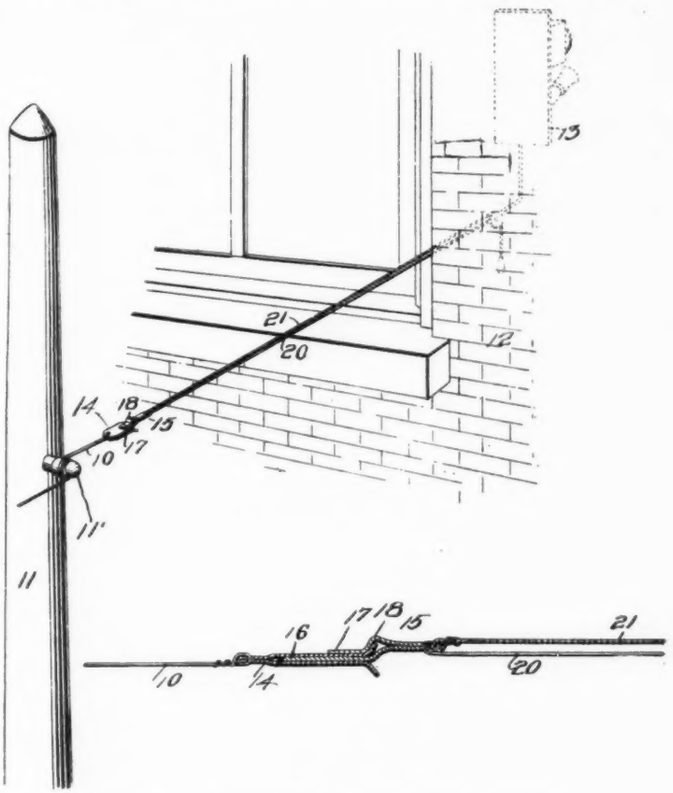
720,085—TELEPHONE TRANSMITTER.

diaphragm and the ring I keeping the carbon in place. A pair of springs F, F, attached to the bridge D, keep the diaphragm pressed against the inside of the front plate B.

720,103—G. R. Bonham, telephone protecting device.

This is a combined lightning, sneak current, dynamo current, telegraph current, divers other currents, and scare arrester, for telephone lines. No alarm need be felt by the most timid person over having a ravening wild telephone in the house as long as this gentle protector is at hand. No more will the savage lightning be permitted to desecrate our homes and work its pirate pleasure among our Lares and Penates, not to mention singeing feminine pompadours that may have been our pleasure and our pride. In the hour of perplexity, when sages have despaired and the wisest have withdrawn from the glare of the elusive and victorious fluid, which laughs at spark gaps, and trifles with choke coils as paltry playthings in its course to earth, a champion has arisen. The solution of the vexed and sorry question is found. Like all truly great solutions, the answer is so simple we stand aghast at our own previous density. It is this—when afraid of your telephone, pull a string and cut the line off, as far away from the house as possible. Such is the simple yet beautiful conception that comes to us from the Empire Prairie, county of Andrew—not Jackson, but Missouri.

In the figure herewith 13 (!) is the telephone, 21 is the



720,103—TELEPHONE PROTECTING DEVICE.

wire connection to a separable clip 14-18 on the nearest pole 11, and 20 is the string that you pull. This string might be useful in a variety of ways. If unwelcome calls were expected, pull the string. The air gap does the rest. It is guaranteed to stop all ringing current. If conversation waxes warm to the verge of violence, and assault is imminent over the wire, pull the string. If the lady of the house, or her charming daughter, were at the 'phone and the wires inductively gathered up some stray scraps of race-track talk or fancy stories, how handy the string would be, if their indignation permitted them to remember it. But, on the other hand, would it not suggest some unpleasant things. Might not central get real coarse, and if she thought you a trifle presuming, and amend the popular slang to "Pull your string"?

One point must not be overlooked in this matter, and that is the benefit derived by the lineman of the local company. Somebody has got to climb that pole to put the clip back, every time the string is pulled. If this is Mr. Lineman he should thank his stars for such excellent opportunities to exercise his patience and perseverance. It might get a little monotonous if the same pole had to be climbed all the time, but if one subscriber had such a convenience and protection the manager would, of course, have to supply it to all the others, at the risk of losing his popularity, and so Mr. Lineman would probably get plenty of variety—also plenty of exercise, especially after a lively thunderstorm.

Wisconsin Independent Telephone Association Convention.

The annual convention of the Independent Telephone Association of Wisconsin was held at Milwaukee on February 11 and 12, 1903. The opening session was called to order at the Convention Hall of the Hotel Pfister at 12 o'clock, noon, on Wednesday, February 11. President Richard Valentine read his annual address, in which he spoke of the continued rapid growth of the Independent telephone business in the state. Many companies had increased their capital stock, and during the year forty-one new telephone companies, with a total capital of over $1,000,000, were organized, and the present number of Independent companies in Wisconsin was 200, having 1,000 toll stations, 200 exchanges and 30,000 subscribers. In most of the cities still remaining under monopoly rule exchanges were being built or contemplated. Great progress was also being made in developing the rural telephone business. Long-distance copper trunk lines were needed more than ever to connect the many local systems, but there was the strongest assurance that these would be built the coming season. He also spoke of the final decision of the Berliner patent suit.

On motion that a committee on resolutions be appointed, the chair selected Messrs. Crowley, Teasdale and Goodrich.

On motion that a committee be appointed to consider the advisability of publishing an association organ, the chair appointed Messrs. Harper, Dinsmore, Schernecker, Munsell, Abbott, Lloyd and Winter.

A committee of five on legislation was appointed, consisting of Messrs. Harper, Hutchinson, Ferdinand, Larson, Valentine and Cavanaugh.

Motion was made and adopted that a commitee of five be appointed to consider and revise the schedule of toll rates, and the chair appointed Messrs. Hutchinson, M. D. Larson, Harper and Teasdale.

A committee of five was appointed to draft suitable memorial resolutions upon the death of Mr. Lohmiller and Mr. Collonious, members of the association. The committee appointed was Messrs. Keelyn, Bell and Kepler.

The meeting then adjourned, reconvening at 2:30 p. m.

Mr. Keelyn presented the report of the memorial committee upon the death of Mr. Lohmiller of the La Crosse Telephone Company, a member of the executive committee, and Mr. Collonious of the Central Wisconsin Telephone Company of Portage, and the same was adopted.

Mr. A. L. Hutchinson of Weyauwega of the Interurban Telephone Company then read a paper of "Uniformity of Toll Rates."

Mr. C. W. Farr of Chicago of the Farr Telephone and Construction Supply Company made an address on the subject of "Generators," discussing at length the many requirements of a proper telephone generator.

Mr. J. E. Keelyn of the Western Telephone Manufacturing Company, Chicago, gave a talk on "New and Old Telephone Problems." He discussed briefly the early history of the telephone and talked of the rapid progress made by the Independents.

On motion a committee was appointed to devise plans for interesting the citizens of Milwaukee and securing an Independent telephone exchange in that city. This committee consists of Messrs. Cavanaugh, Lloyd, Ferdinand, Baer and Keelyn.

Mr. J. C. Harper, Madison, of the Dane County Telephone Company, talked on the subject of "Prospective Telephone Legislation," in which he referred to bills so far introduced in the legislature and discussed the effect they would have on the Independent telephone business. He advised against the bill compelling interconnection between different telephone companies, as this would be to the disadvantage of the Independents.

Mr. Valentine discussed such a bill and gave many reasons against the passage of such a measure.

The meeting was then adjourned to 10 a. m. the next day.

THURSDAY SESSION.

Mr. W. A. Taylor of the Standard Telephone and Electric Company, Madison, read a paper on the "Comparative Merits of the Magneto and Central Energy systems."

Mr. Dinsmore presented the report of the committee on an association publication, in which the committee advised against such a publication and asked the convention to consider the selection of one of the many telephone organs now being published as the official publication of the association, and, on motion, the report was adopted.

Mr. A. L. Hutchinson presented the report of the committee on toll rates and the report was discussed at length by Messrs. Valentine, M. D. Larson, Theilman, A. W. Larson, Crowley, Hutchinson, Bell, Lloyd, Hackney, Nate, Fehland, Croll, Slater, Bryant and Middlesworth and Mansfield, which brought out a great variety of opinions on this subject, and, after some amendment, the report was adopted.

A new resolution was also adopted on this subject, that to encourage the investment of capital to build long-distance copper toll lines, the companies of the association would be willing to handle such long-distance business for a commission not to exceed 15 per cent of the out-going tolls. Mr. Crowley suggested that all the companies in the Independent association take a proportionate share in the long-distance company, to the amount of 10 per cent of their own investment, and in this way the long-distance lines would soon be built.

Then followed a discussion of the toll rates and lines, after which the meeting was adjourned, reconvening at 2:15 p. m., when Mr. Harper presented the report of the committee on legislation to the effect that the legislative bill giving telephone companies the right to the indiscriminate trimming of trees be opposed, as this would arouse public sentiment, and that the bill to regulate the telephone and toll rates be also opposed, unless the same could be modified.

The committee further recommended that a bill be introduced in the legislature to prohibit discrimination in telephone charges in cities belonging to the same class, and for this purpose the citizens of the state be divided into a certain number of classes. Such report was adopted, and on motion the legislative committee was made permanent.

On motion a committee of three was appointed to nominate officers, consisting of Messrs. Bell, Hackney and Goeselin.

Mr. Hackney read an extract on rural telephones from a magazine, and as this article advised the construction of cheap rural lines it was criticised by Mr. Hackney and others in the convention.

Mr. Crowley presented the report of the committee on resolutions, in which the press of Milwaukee was thanked for its efforts to inform the citizens of Milwaukee of the growth and importance of the Independent telephone business of Wisconsin. And further, that this association re-

quest its members not to patronize supply companies to other Independent companies, attempting to undermine Independent companies now established. Further, that only such companies that connect their toll lines and exchanges with other legitimate Independent companies, where opportunity offered, shall be eligible to membership in this association. And further, that thanks be extended to the officers and committees of the association for their faithful service the past year, and that in future meetings all supply companies close their exhibits during the hours that the convention is in session. This report was discussed, and after a slight amendment was adopted.

Attention was also called to the fact that where any Independent company was buying its supplies from certain companies it was patronizing the Bell company, and it was the sense of the meeting that no Independent company should continue assisting in this way.

The secretary then read the following list of companies that has made application for membership, and on motion each application was accepted: The Sheboygan Telephone Company, Sheboygan; the Northwestern Telephone and Electric Company, Milwaukee; Mt. Horeb Independent Telephone Company, Mt. Horeb; Valley Telephone and Telegraph Company, Green Bay; McFarland Telephone Company, McFarland; Citizens' Telephone and Electric Company, Kenosha; Menominee Range Telephone Company, Iron Range, Mich. Maquon Telephone Company, Thienville; Rock River Valley Telephone Company, Lake Mills; Wausaukee Telephone Company, Wausaukee; Mazomanie Telephone Company, Mazomanie, and the American Electric Fuse Company, Chicago; Automatic Electric Company, Chicago; Illinois Electric Specialty Company, Chicago; Swedish-American Telephone Company, Chicago; Holtzer-Cabot Electric Company, Chicago; Green Telephone and Electric Manufacturing Company, Milwaukee.

The secretary then read his annual report for the past year, showing the financial condition of the association.

On motion an assessment of one cent per telephone and two cents per mile of toll line was levied upon the members.

Mr. Hackney then presented the report of the committee on nominations as follows:

President, Richard Valentine, Janesville.

Vice-president, H. G. Slater, Waupaca.

Secretary-treasurer, H. C. Winter, Madison.

Members of the executive committee: C. W. Twining, Monroe; F. H. Sweet, Fond du Lac; J. C. Harper, Madison; W. F. Goodrich, La Crosse; J. Thielman, Merrill; John M. Baer, Appleton; M. F. Smith, Hixton; J. C. Crowley, Jr., West Superior, and William J. Bell, Baraboo, committeemen at large. On motion this report was adopted.

Mr. Valentine thanked the association for the honor again bestowed upon him. He predicted that this present year would see the construction of the much-needed copper toll lines; that all should co-operate in this work.

On motion it was decided to hold the June meeting at Madison, and the next annual meeting again in the city of Milwaukee.

Mr. Harper then spoke of the telephone situation in Madison and what new methods were employed by the Bell company in attempting to secure a footing in that city.

On motion that a committee of two be appointed to devise a design for advertising Independent telephone stations, the chair appointed Mr. Birch and Mr. Ritter and requested them to report at the June meeting.

On motion the convention then adjourned.

CONVENTION NOTES.

Lindsley Bros. Company, Chicago, was represented by Edward G. Lindsley of Menominee, Mich.

The Automatic Electric Company, Chicago, did not make a display of its apparatus, but was represented by J. F. Crook.

John A. Roebling Sons' Company, Trenton, N. J., was represented by Geo. C. Bailey, W. H. Slingluff and R. B. Abbott.

M. B. Austin & Company, Chicago, was represented by A. Meinema. The company did not make an extensive display.

The William-Abbott Electric Company, Cleveland, Ohio, made no display, but L. Sands, president of the company, represented it.

The Kellogg Switchboard & Supply Company, Chicago, exhibit was in charge of G. L. Ainsworth, displaying the well known products of this company.

The Standard Underground Cable Company, Pittsburg, Pa., displayed its well known line of wire and cable. E. J. Pietzcker and J. R. Wiley were in charge.

The Eureka Electric Company, Chicago, displayed a full line of Eureka switchboards and telephones, the exhibit being in charge of I. J. Kusel and H. Rosenow.

The Illinois Electric Specialty Company, Chicago, exhibited a full line of pole changers, ohmmeters and thermostats, the display being in charge of F. B. Patten, president of the company.

The Holtzer-Cabot Electric Company, Chicago, was represented by E. R. Harding and T. M. Meinema. The company exhibited several styles of its motors and a full line of generators.

The Electric Appliance Company, Chicago, exhibited its new type transmitter, Noxem receivers and Eaco dry battery, S. A. Dinsmore and J. D. McMullen having charge of the exhibit.

The Sterling Electric Company, La Fayette, Ind., exhibited its full line of protectors, telephones and a switchboard of the common battery type, the exhibit being in charge of F. E. Rotchka and Clyde Dunseth.

The Illinois Electric Company, Chicago, exhibited a full line of Peirce specialties, including pole top terminal, drills, brackets and other devices. N. G. Harvey, C. W. Bacon and C. L. Peirce were in attendance.

The Farr Telephone & Construction Supply Company, Chicago, presented a full line of telephone apparatus and supplies and called special attention to its Jumbo magneto, Chas. H. Farr having the exhibit in charge.

The American Electric Telephone Company, Chicago, devoted special attention to the exhibit of its four-party line selective apparatus, exhibiting also numerous types of telephones and switchboards, H. P. Blackledge and Max W. Zabble being in charge.

The Standard Telephone and Electric Company, Madison, Wis., was represented by J. H. Parish and W. A. Taylor. This company exhibited a full and complete line of Standard apparatus, which elecited many congratulatory remarks from interested delegates.

The Green Telephone and Electric Manufacturing Company, Milwaukee, Wis., exhibited the Green solid back transmitter and a complete intercommunicating system, the exhibit being in charge of J. F. Whittemore, who took particular pains to show that the Green transmitter is worth its weight in gold.

The Western Telephone Manufacturing Company, Winthrop Harbor, Illinois, exhibited a one hundred line Western Express switchboard of the regular pattern, and a one hundred line Western Express switchboard new style, with flash-light clear out. A full line of telephones was also displayed, particular attention being given to its new ringing and listening key and transmitter. The company

was represented by J. E. Keelyn, C. T. Sanders and W. G. Peacock.

Julius Andrae & Son's Company, Milwaukee, Wis., was represented by F. T. Andrae, J. C. Schmidtbauer, H. J. Meyer and A. K. Kummer. The company exhibited telephones, switchboards and supplies, making the new Andrae transmitter a special feature.

The Chicago Pay Station Company, Chicago, was represented by J. C. Finch. Pay stations and call registers were the principal devices upon exhibition, special attention being called to a new three-slot machine wherein only one coin can be deposited at a time.

The Chicago Telephone Supply Company, Elkhart, Ind., displayed a full line of bridging, series and common battery telephones and switchboards, the exhibit being in charge of S. A. Duvall, who exemplified in many ways the maxim of his company that "Chicago telephones satisfy."

The Stromberg-Carlson Telephone Manufacturing Company, Chicago, was represented by J. J. Nate and A. S. Munsell and displayed its usual line of telephones and accessories. It had been the company's intention to display at Milwaukee the exhibit prepared for Topeka, Kansas, but the consignment was delayed in shipment from Topeka and failed to arrive at Milwaukee in time for the convention.

The American Electric Fuse Company, Chicago, was represented by Frank G. Jones and J. A. Kenney. The company exhibited a two hundred pair combined protector and distributing rack, complete, and a full line of B apparatus designated as a cheaper form of sneak current protectors. Special stress was placed upon the self-restoring and self-soldering heat cartridge, which was one of the special features of the convention.

The Vought-Berger Company, La Crosse, Wisconsin, made quite an elaborate showing of its pendent, wall and desk telephones, exhibiting also a fifty drop switchboard. This company devotes special attention to the finishing of wood work entering into the construction of switchboards and telephones. During the convention a one hundred drop switchboard was sold to the Onalaska Telephone Company. The exhibit was in charge of M. I. Berger and C. M. Dougherty.

THE LIFE OF CREOSOTED TELEPHONE POLES.

At a meeting of the Dublin section of the British Institution of Electrical Engineers, held last December, Mr. A. T. Kinsey gave some interesting figures regarding the life of creosoted telephone poles. Timber is preferred to iron in pole-line construction on account of its lower cost, but, when used, some means of rendering it capable of resisting the attacks of dry and wet rot are necessary. Various methods have been tried, but all have been abandoned except creosoting. One of the best timbers for poles is Norway red fir. All timber must be thoroughly seasoned and dried before treatment.

The quantity of preservative used is eight pounds per cubic foot. It does not penetrate to the heart of the pole, reaching only to a depth of one or two inches when the timber is very dense. This leaves an unprotected portion—the heart and the interior margin of the zone. This unprotected zone is where dry rot usually sets in, but dry rot is comparatively rare. It is found that in course of time the creosote sinks to the base of the pole, forming a thick crust on the surface of the latter where it is most needed as a protection against wet rot, as this latter attacks from without and proceeds inward. In 1880 the life of treated poles was found to be thirty years. Poles taken down in that year which had been planted in 1849 and 1850, were found to be sound as when erected. Since then creosote has deteriorated in quality owing to the increased value of some of its constituents, so that it seemed desirable to investigate the matter again. The author has traced the erection of creosoted poles in Ireland as early as 1858, and again in 1861, but as a systematic branding of the date of creosoting was not begun until 1873, it is impossible to identify with certainty the poles creosoted before that time. The result of an examination by percussion showed that the poles thus branded are apparently quite as sound as when first erected. Poles dated 1877 were being taken down, but were apparently as good as new, and would pay for re-erection.

RURAL TELEPHONE LINES IN IOWA.

A recent report from Dubuque says:

Farmers in the east will be interested in the growth of the telephone in the Northwest. Farmers in the state of Iowa have probably a fuller cognizance of the immense advantages to be reaped through the use of the telephone than those of any other state in the Union. The growth of what are commonly termed farmer lines or rural lines or mutual lines in Iowa has been unprecedented, and is quite unapproached by any similar growth in any other part of the country. In that state telephone systems have sprung up over night, figuratively, if not literally speaking. It is the exception now rather than the rule to find a farm-house, no matter how far it may be from centers of civilization, without the familiar jingle of the telephone bell.

A few years ago telephones were thought profitable or practical only in large cities. The farmers of the country were the very last class of people thought of as possible telephone users. But a few of the more progressive among them were thoughtful enough to foresee what a great boon telephone communication would be to farm life. They wanted telephone service. And if the company operating in the nearest city could not be persuaded to build lines and give them connection they went to work and built the lines themselves, buying cheap instruments, stringing wires on fences as part of the circuit. They wanted telephonic connection, and they wanted it cheap. And consequently cheap construction was the rule. This very naturally has involved rebuilding in almost every instance, for once a resident has been educated to the use of the telephone he will never willingly do without it.

This work has gone on for the past few years in every rural community of the United States, but the fullest development has been reached in Iowa. Nearly every county in that state has a complete network of telephone wires. Generally these rural systems are constructed by a dozen or fifteen neighbors, who only wish communication between themselves. But after the first taste they want connection with as many other people as they can reach. Hence lines have been run connecting the different farmer systems with each other, and other lines joining these connected systems with small exchange towns, and these in turn are connected with larger towns, and so on, until the use of the telephone has become almost universal in the rural section there.

Robert Alexander, acting for the law firm of Alexander & McGill, of Philadelphia, Pa., bought the Standard Telephone Company of Atlanta, Ga., February 5, at auction in that city. He paid for the property and all the effects of the company, $200,000, which was fixed by the courts as the upset price. The sale was on foreclosure of a mortgage held by the City Trust, Safe Deposit & Surety Company of Philadelphia.

The International Traction Company of Lockport, N. Y., will install a telephone system on all its lines, including the local line, the Buffalo and Olcott division and Niagara.

QUESTIONS AND ANSWERS

Conducted by J. C. KELSEY, Professor of Telephony, Purdue University.

In the December number, under "Practical Telephony," by P. Kerr Higgins, I notice that "the current necessary for a Blake transmitter is about thirteen amperes at one volt pressure." Should this not read thirteen hundredths of an ampere? I have known the Lelande cell to give good service for a year and a half on the Blake transmitter, which they could not have done with a drain of thirteen amperes, unless it were on one of the Blake's here in Newton, which are not used very often.—F. L. O.

The contention is right, for no transmitter would stand such a current, much less a Blake. We are inclined to

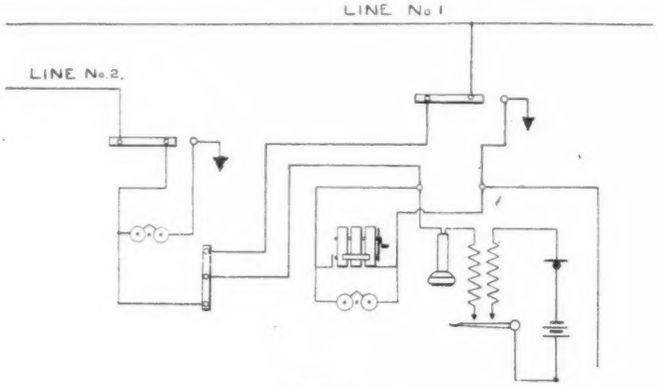


FIG. 1.

think that the transmitter is not worth discussion and the patronage it receives in the place mentioned is all that it deserves. It deserves a place only as an antiquity. Nearly every enterprising company has discontinued its use, but there are still companies who do not seem to know better. It is to be suspected that when a company has paid a royalty of eighteen dollars a year upon such a villainous mechanism, which only costs $1.75 to make, they like to hold onto it,

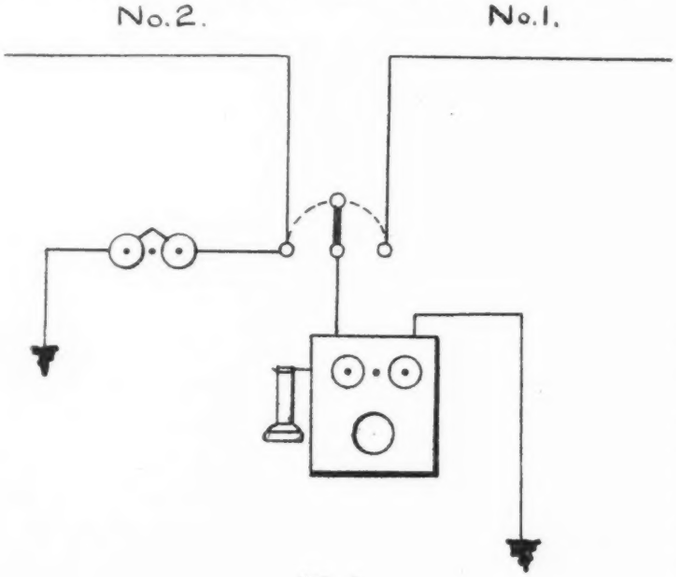


FIG. 2.

when it costs nothing, for the Bell company could hardly have the nerve to ask for a royalty upon them now.

Is this circuit correct for a Stromberg-Carlson extension bell for bridge grounded lines? See Fig. 1.—C. O. M.

The connections of the switch are indefinite, otherwise it will work well. From the sketch it appears that the telephone set operates on one line, and can be used on the other line when the extension bell rings. With such a switch it would be hard to arrange it so that the telephone set could be connected to either line singly and still allow the two lines to be connected together without entirely cutting off the talking instrument. Possibly this is what is intended, connected as in Fig. 2, so that the two lines can be thrown together, without the possibility of bridging on the talking set and depending upon the extension bell to ring a disconnect or through signal. It would appear that Fig. 3 would give more range of action, as it allows of talking on each line separately, of connecting them together and talking to both parties.

When an alternating current flows through an induction coil, and meets a regular current from a battery, will it resist the regular current and neutralize it, if of the same strength, when the currents meet? And does the alternating current help and strengthen the regular current when flowing with it? Is the alternating current helped or resisted or affected in any way in the least on the other side of the coil from the regular currents?—F. W. S.

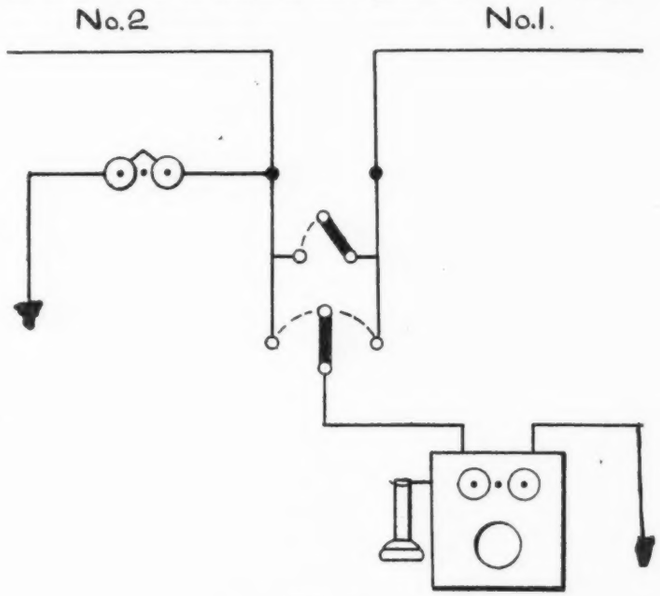


FIG. 3.

The nearest practical proof of the question is particularly exemplified in the cut-over common battery subscribers' talking set, which has been accomplished by the insertion of a condenser in the bell circuit, so that the local battery set would work on local battery exchange connections, and the next day possibly be working on common battery. The condenser prevents the exchange battery from flowing through the instrument, except when the telephone is off the hook. Such telephone sets do not work any too well on common battery and there is always a general haste to change the local battery instruments to regular common battery. The reason for this is the combination of an alternating current from the local battery induction coil, induced by the primary into the secondary, and the continuous or regular current from the exchange battery. Here we find an actual case and the well-known results go to prove that the alternating current will in a measure neutralize the regular current.

Another proof, which is highly practical and a fair test of

such conditions mentioned, is the well-known fact that for long-distance booths for considerable time some companies adhered to the idea of making the instruments of local battery nature, yet allowing them to enter the common battery station, because considerable local nickel business was done over the lines, thinking that for real long-distance business the common battery instrument would not do, so they braced it up with local battery. It is a fact that such a combination will not work at all well on long-distance business, which is a further proof of the results of a combination of alternating and continuous current.

The second question: "Does the alternating current help

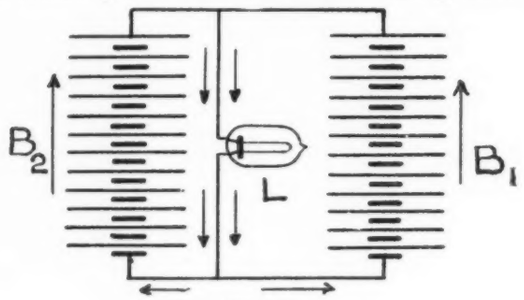


FIG. 4.

and strengthen the regular current when flowing with it?" Looking at Fig. 4, let us supose that the alternating current is of one direction—that is, only moving through a half cycle—and let it be represented by battery B^2,with the arrow pointing upward, the direction the same as the arrow of battery B^1, which is the regular current battery. Suppose a lamp, L, to be connected as shown in the drawing, which will make the two batteries in parallel, thus proving that the upward alternations do not add a thing to the regular battery, for our lamp continues to receive just twenty volts, its original voltage. Now suppose that the downward alternations begin, and in Fig. 5 we will have B^2 represented by a downward arrow, and this time opposing battery B^1. Now look at the battery directions closely, and we find that the lamp L will get no battery, because the two batteries may be said to oppose one another.

Therefore we find that in a complete cycle, or two alternations, the directions of the alternating and continuous currents agree, without producing any re-enforced effect upon the continuous or regular battery current. When they oppose one another they oppose exactly, and no current

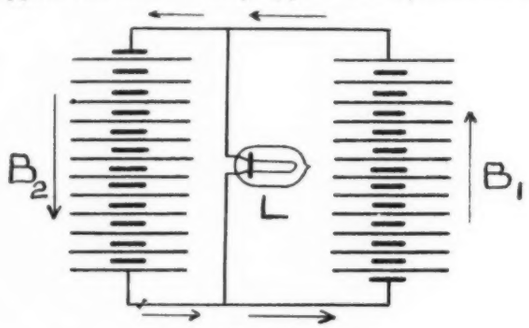


FIG 5.

flows to a bridged lamp or receiver in the actual case. From this an average may be obtained which may be assumed to be ten volts. According to the reasoning, the regular battery voltage would fluctuate between zero and twenty volts, and in alternating currents the average value would be the maximum voltage multiplied by .707, which would make the regular battery voltage have a value of 14.1 volts. This proves that the combination of two currents of equal strength, continuous and alternating, does not help and strengthen the regular or continuous current.

The third question: "Is the alternating current helped or resisted or affected in any way in the least on the other side of the coil?" which is meant in the primary. Consider a transformer, bridged on the mains. It takes no current in the primary winding, because it has its own electromotive force, due to self-induction, which equals the electromotive force of the generator. Suppose some one turns on a few lamps, which will cause current to flow in the secondary winding enough to burn all the lamps brightly. The transformer must be self-regulating, as no hand is near to adjust a possible rheostat, and it is entirely self-regulating. The current which is set up in the secondary has an inductive effect called a mutual induction, which weakens the self-induction or the electromotive force of self induction, or its resisting power to the main current, just enough to let the required amount to flow into the primary to induce the proper amount for the lamps in the secondary circuit. If one wants to prove this he can short circuit the secondary circuit of a transformer, which will weaken the resisting power of the primary so as to allow an abnormal amount of current to flow in, which blows out the primary fuse. Now, according to Fig. 6, we have a primary winding, and the secondary, with its circuit closed through the low resistance regular battery, which is nearly a short circuit load, hence the alternating current in the primary is strengthened.

There are several ways that this reasoning can be attacked, and we cheerfully invite all discussions possible.

In a seventy-five pair cable, aerial, one mile in length, would it be best to have the cable made of No. 20 wire instead of No. 22? Would the additional cost of No. 20 over No. 22 make cable enough better to warrant the additional cost? Would there be

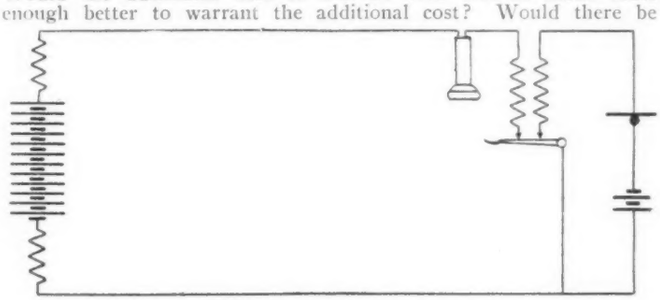


FIG. 6.

any danger of induction in aerial cable paralleling the street railway, and electric light lead, providing the wires were connected through cable in pairs?—C. K. A.

The universal adoption of the 400 pair No. 22 cable in large cities has already proved that the present White solid back and all other transmitters of the low resistance type are inefficient. There is in process of construction, or by this time has been constructed, a particular style of transmitter which easily overcomes the additional evil effect of No. 22 cable.

It is needless to say that this transmitter is being built by an enterprising Independent concern, which is ever in the lead of the Bell company in meeting engineering problems. To further illustrate the use of cable on long haul work, such as trunk lines, say, from four to ten miles in length, the specifications call for No. 19 cable. For short exchange work, the average being less than one mile, the No. 22 is sufficient.

Assuming a price of twenty-nine cents per foot for seventy-five pair cable, No. 20 in size, the one mile length would cost $1,531. Also assuming that No. 22 cable costs twenty-four cents per foot, then one mile would cost $1,267. The difference in price would be about $275. If the cable is never to be more than one mile long the difference in the price is worth saving, considering the increased (?) benefits of No. 20. The capacity of the two cables are to be the same and the difference principally lies in the resistance. Assuming that the conditions cover mostly short haul business, the No. 22 cable is sufficient.

There should be no danger of induction from paralleling

if the wires are connected in pairs. However, there are many cables which have an alternating ringing current flowing through a single wire of the cable, in the case of furnishing ringing power to branch offices, without one indication of noise. Running toll lines into the exchange through a subscriber's cable is ofttimes conducive to much trouble. Long toll lines necessarily are more liable to unbalance than a short exchange line, because it may be said that there is a greater charge or potential as regards the earth, hence when grounded greater noise is heard. When one of these long lines in the cable gets out of order its trouble spreads to all the other lines in the cable, and they become supersensitive also. Therefore, the least unbalance, which in a healthy line would amount to nothing, here assumes great proportions and makes everything noisy, as

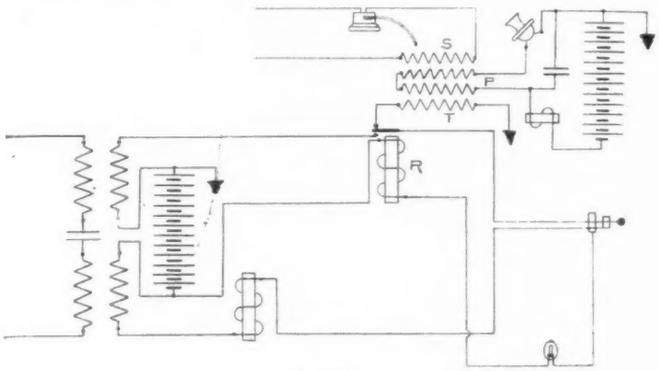


FIG. 7.

one might say, on suspicion. It is well to try running the toll lines through the cable until this is proved to local satisfaction. Long-distance companies have permission to build pole lines in large cities, where none others exist, because of the fact that cables must be avoided as much as possible for several reasons. When one considers that in these days of high voltage transmission, say 25,000 volts, and the toll lines, being so close at times, often have an electrostatic potential of 10,000 volts in regard to the earth. Then who wonders that with bad insulators and bad wiring and wet days that lines are noisy without apparent cause?

In a common battery drawing, I noticed the induction coil to be represented by three windings, marked primary, secondary and tertiary. What is the tertiary winding used for?—W. O. E.

In the Bell system the tertiary is a winding of about one-fifth of the secondary winding and is used in connection with the busy test, which this system uses in connection with trunk operators. To save a little time is the principal idea, for it gives the test simply by the trunk operator touching the tip of the plug to the sleeve of a busy jack. It does

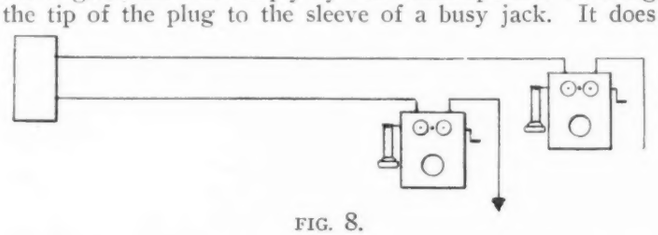


FIG. 8.

not betray to the awaiting subscriber that the trunk operator is testing by reason of a relay which holds the line open until the plug is inserted into the jack. As long as the relay R in Fig. 7 is not energized the tip of the plug is in direct connection with ground through the tertiary winding. The touching of the tip to a busy jack gives the operator the busy click, just as the ordinary operator has to throw in her listening key. This way of testing is automatic, as it does not put any work on the operator.

One Independent company uses the tertiary winding for the chief operator's listening tap, so that she may listen on the operator without said operator being aware of it. An interesting trouble can happen to the circuit shown in Fig. 7. Suppose that the tip and sleeve of the plug are crossed, then battery will flow through the relay R and energize it, pulling the armature away from the tertiary connection. This breaks the circuit, causing R to release itself. It no sooner does this, when battery flows again and performance is repeated. This is a real induction coil now, and it acts directly upon the operator's induction coil and entirely cripples the

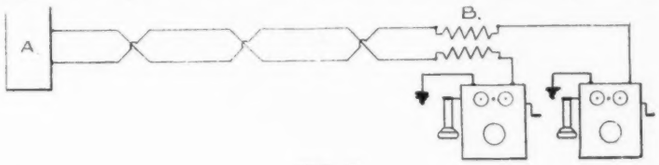


FIG. 9.

position. It sounds like a generator was connected on the order line. The operator can relieve the trouble by plugging up each successive trunk until the noise disappears, which proves the afflicted trunk, which is then reported to the switchboard man.

We have two grounded lines, one twenty-five miles long, and the other six miles long. The longer line parallels the shorter line throughout its entire length, as shown in Fig. 8. The cross talk is so bad that both lines cannot be used at the same time. (1) Could not the cross talk be eliminated by inserting a repeating coil at B, in Fig. 9, and transposing the lines between B and A, which is central? (2) Would a suitable resistance coil inserted in the shorter line, in order to make it equal in resistance to the longer line, be of any advantage, and would either scheme work, and if not, why?—J. A. D.

Cross talk is caused by three factors—leakage, electrostatic induction and electromagnetic induction. In this case the leakage factor is the most prominent one. Looking at Fig. 8, it is plain that the shorter line acts as a return for the longer one, and whatever wave passes through the longer one is bound to be taken up by the shorter line. Earth currents would be main trouble to the shorter line when the longer line was in operation. This cross talk between the short to the longer line would come more from induction than earth currents. No amount of transposing can eliminate induction between two grounded lines, on account of the inability of one line to neutralize the induced currents of the other. In a metallic line the opposing or disturbing line induces different potentials on the sides of the metallic line, one weaker than the other. If we transpose the sides, which act like the secondaries of a transformer, consecutive neutralizing values are generated which kill one another. A

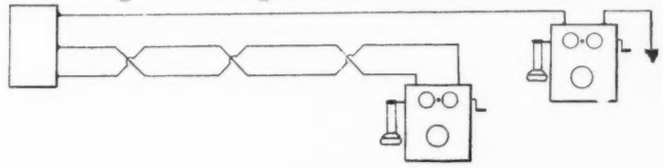


FIG. 10.

grounded line has no power of neutralization and receives the charge from the disturbing wire, and the only thing it can do with the charge is to carry it to ground through the telephones at the end. Hence one hears the noises of induction.

Fig. 9 shows the two lines grounded, transposed and also in inductive relation through the windings of a repeating coil. This scheme would only perfect the cross talk existing between the two circuits, and instead of cross talk we would have real talk between the two lines. The insertion of resistance to make the lines equal would give no advantageous effect, as such balance would not help matters.

From the original drawing it could not be a certainty that the repeating coil was to be placed as in Fig. 9. However, placed any way, it would only result in placing the two lines in inductive relation and make it act as a two-party line.

It might be of advantage to insert condensers in the line, as they possibly would have a retarding effect on earth currents. If this would eliminate the earth currents a part of the battle would be won. However, the real solution of the case is to make the short line fully metallic, according to Fig. 10, and transpose as much as necessary to eliminate the induction. Then earth currents or leakage is entirely eliminated and the inductive enemies are all that is felt, and they should be handled easily. It is a hard proposition to dispose of all three enemies by any other means. Try the condensers and parallel them with impedance, and see what effect it will have.

TELEPHONES IN THE COUNTRY.

"City people whose neighbors use their telephones think they know all about trouble," said a ruddy-faced amateur farmer, "but I'll compare notes with them any day. If you are not obliging to your neighbors in the country you would better move back to town; so this is what we go through with in order to be obliging. We have the only telephone in our vicinity; and my wife and I ought to draw salaries as rural messengers."

"The other day a call came to our telephone for some one in town who wished to talk with Mrs. Jinks, our tenant's wife. So my wife had to leave her sewing, don her sunbonnet and plod across the rough fields a third of a mile to tell Mrs. Jinks to come to the telephone. When Mrs. Jinks got ready she lumbered up to our house with a fat baby under each arm and found out that Rosy, a friend of hers in town, wanted her to come and bring her out to spend the day.

"'Naw,' bawled back Mrs. Jinks, 'ain't got no hoss.'

"In a day or so another friend of the Jinks family telephoned out to say that she and three children would spend Sunday with the Jinkses, and Mr. Jinks must come in with the wagon to bring them out. My wife could not answer that the Jinkses had no horse, as they had just got one; so she promised to deliver the message. She gave the errand over to the Jinkses to me; I intended to attend to it and forgot it. The folks in town got ready and waited all day Sunday, but no Mr. Jinks appeared. About Tuesday there was a great disturbance on the farm, involving all the Jinkses, my brother and myself, and both of our wives. The message hadn't been carried and everybody was to blame.

"This is only a sample," said the amateur farmer, according to the Detroit Free Press. "We have other neighbors near and far. But our house is the telephone office of the district. People in town get mad at us and people in the country get mad at us; our lot is hard."

CENTRAL MISSOURI TELEPHONE ASSOCIATION MEETING.

The second annual meeting of the Central Missouri Telephone Association was held at Sedalia, Missouri, on February 27. The meeting was called to order at 2 p. m. After the president's annual address the following papers were read:

"Toll Line Construction, Rates and Exchange of Toll Business," by J. Roy McCanne, St. Louis.

"Exchange Construction," F. S. Leach, Sedalia, Mo.

"Exchange Telephone Rents, Measured and Sliding Rates and Exchanges' Compensation for Handling the Business of Toll Lines." J. A. Hudson, Columbia, Mo.

"Farmers' Lines, Construction and Maintenance, Rates and Exchange Compensation of Handling Independent Farmers' Lines." C. E. Betts, Fayette, Mo.

"Telephone Business in Missouri as a Paying Investment." W. B. Scruggs, Harrisonville, Mo.

"Consolidation of the Telephone Interests in Central Missouri." W. F. Hall, Clinton, Mo.

At the conclusion of the meeting a banquet was given at the Huggins Hotel.

OUR NEW PAVEMENT.

They took a little gravel
And they took a little tar
With various ingredients
Imported from afar.
They hammered it and rolled it
And when they went away
They said they had a pavement
That would last for many a day.

But they came with picks and smote it
To lay a water main;
And then they called the workmen
To put it back again.
To run a railway cable
They took it up some more;
And then they put it back again
Just where it was before.

They took it up for conduits
To run the telephone;
And then they put it back again
As hard as any stone.
They took it up for wires
To feed the 'lectric light,
And then they put it back again,
Which was no more than right.

Oh, the pavement's full of furrows;
There are patches everywhere;
You'd like to ride upon it,
But it's seldom that you dare.
It's a very handsome pavement;
A credit to the town;
They're always diggin' of it up
Or puttin' of it down.

—Washington Star.

THE CUYAHOGA TELEPHONE COMPANY.

The report of the financial affairs of the Cuyahoga Telephone Company, Cleveland, Ohio, made at the annual meeting on February 2d, showed total assets of $5,878,339.62 and total liabilities of $5,907,482.34, the deficit to balance being $29,142.72. Of the liabilities the Federal Telephone Company is put down at $475,392.92. The gross earnings for the year 1902 were $385,852.14, and the total expenses were $229,709.59. The total deductions from the income were $155,600.48, making the deficit noted above. The treasurer's report showed that the deficit was due to extravagent management, in having more employes than there was work for and too low rates. The president reports that there has been poor collections, and that some steps will be taken to correct the matter. The only change in the directorate was the retirement of N. A. Gilbert and the election of J. R. Sprankle to fill his place. The officers are as follows: President, F. S. Dickson; vice-president, E. W. Moore; secretary, James B. Hoge; treasurer, R. W. Judd.

EXPORT OF COPPER.

The most marked advance in export trade during the year 1902 has been in manufactured copper, which shows a gain of twelve million dollars; the export of which has jumped from $33,534,899 in 1901 to $45,485,598 in 1902.

An Automatic Telephone Operator*

By WILLIAM J. HAMMER.

For a considerable period of time the public mind has been steadily educated up to a high appreciation of, and great confidence in automatic time, energy, and money saving appliances. In the telephone field the subject of automatic telephone exchanges has been one which has attracted a great deal of attention ever since the original work in this direction of Messrs. M. D. and F. A. Connolly and F. J. McTighe, whose system the writer had the pleasure of examining as long ago as 1881, at the first electrical exhibition held in Paris.

The above system has been the basis of very many of the patents which have since been taken out on automatic telephone exchanges; and it is my privilege to present for your consideration a radical departure in automatic exchanges which embodies a new principle of which it is the pioneer exponent. It is a most meritorious and ingenious piece of apparatus, and is termed the "mechanical operator," in contra-distinction to all other types of automatic exchanges, as it is the only invention which does the work of switching in a telephone exchange in exactly the same manner as is done by the human operator, and by exactly similar means. It is a light machine, and occupies comparatively little space. It is driven by power, and moves mechanically the equivalents of the ordinary plugs and cords in the usual switchboard, connecting the subscribers' terminals together when desired, signaling both parties, and disconnecting the same automatically when parties have finished speaking; and accomplishing this without necessitating any departures from the general arrangement of circuits met with in standard practice; and doing away with all but a fraction of the relays, magnets, electrical contacts and connections essential in all other systems, both manual and automatic.

The multiple system of telephone exchanges has now reached a very high degree of perfection; and it has become more and more costly; and it is well understood that as the number of subscribers connected to any manual or automatic exchange increases the operating and maintenance expenses, increase in far greater proportion than the number of subscribers, because of the increase in the number of multiples.

There is an urgent demand to-day for a system which will very materially cut down these very heavy expenses, and cut off the very heavy outlay now necessary for operator's salaries.

Before entering into a description of the apparatus itself, it will perhaps be as well to consider just what the functions are which the human operator fulfills in connecting and disconnecting subscribers, and in what way the mechanical operator duplicates these functions; and I will, therefore, place them side by side:

CYCLE OF OPERATIONS—THE AUTOMATIC SYSTEM.

1. The subscriber sets his sender to the number wanted, and winds it; his responsibility ending there.
2. The exchange drops his (the subscriber's) terminal shuttle, which starts his sender going.
3. The sender sends a signal into the exchange selector, thereby establishing one of a hundred local circuits.
4. The exchange drops shuttle of subscriber wanted.
5. The motive power at exchange lifts both shuttles into an idle bus bar. (This operation has no parallel in manual working.)
6. The ringing device rings bells of both subscribers.
7. The subscriber on hearing signal takes off his receiver. (This operation not in manual practice, as receiver there is off already.)

CYCLE OF OPERATIONS—MANUAL SYSTEM.

1. The subscriber takes the receiver off its hook.
1a. Operator notes "pilot" light signal and individual signal light.
2. The operator places an answering plug in his jack upon seeing his signal displayed.
3. Operator raises the listening key cam, which depresses the key, thus enabling her to communicate with the subscriber.
4. She asks "number" (this operation has no parallel in the automatic exchange, as the starting of sender is a natural consequence of the dropping of shuttle).
5. The subscriber gives the number wanted.
6. The operator repeats the number to prevent error.
7. Operator must select "jack" wanted.
8. Operator makes a busy test by tapping with tip of her plug the collar of the multiple jack of the line wanted.
9. The operator plugs the multiple jack of subscriber wanted.
10. Operator presses ringing key, thereby ringing up subscriber wanted.
11. Operator restores the listening key, cutting herself out.
12. Operator notes that subscriber's signal lamp goes out.

Next, conversation begins.

Upon its Termination.

8. Subscriber hangs up receiver.
9. Clearing-out magnets drop both shuttles back to rest.
13. Subscriber hangs up receiver.
14. Two (2) keyboard signals light.
15. Operator removes both plugs of the pair from jacks.

This is the entire series of operations gone through in a "successful switch." Should, however, a busy line be called, then the following happens:

BUSY TEST—THE AUTOMATIC SYSTEM.

1, 2, 3, same as above.
4. Operator attempts to drop called shuttle, but it is out of the way, and a special circuit is opened.
4a. Shuttle is for a moment hung up, but then clears out again.
(No further operations follow, as subscriber waits for bell, before taking down receiver.)

BUSY TEST MANUAL SYSTEM.

1, 2, 3, same as above.
4. Operator in multiple board taps the collar of the multiple jack of the line wanted, and she receives a series of "clicks" known as the busy test.
5. Operator tells calling party line is busy.
6. Subscriber hangs up receiver.
7. Operator removes answering plug from calling subscriber's jack.

It will be noted from above that the number of operations necessary caries, and favors considerably the mechanical operating system, those requiring the subscriber's attention are less in the automatic, and he need not wait for the operator to question "number," and after receiving the same repeating to prevent error and saves that time as well as the time often lost in getting the operator to understand the correct number, etc.

COMPARISON OF APPARATUS FORMING SALIENT.

FEATURES OF BOTH SYSTEMS—THE AUTOMATIC SYSTEM.

1. Subscriber's instrument.
2. Sender.
3. Subscriber's line.
4. Protective devices, lightning arrestors, heat coils, etc.
5. Subscriber's terminal carriage with contact springs and connecting rod.
6. Individual magnet.

Above comprises the first group of exchange apparatus, and there are as many above items, as there are subscribers.

FEATURES OF BOTH SYSTEMS—MANUAL SYSTEM.

Same.
Not in Manual.
Same.
Same.
This is represented in a manual exchange by subscriber's line jack.

*A paper read at the 172nd meeting of the American Institute of Electrical Engineers, New York, January 23, 1903.

This is equivalent in office to subscriber's drop or lamp signal and its operating relay, cut-off relay, also puts line lamp out by cutting out line relay.

Same.

AUTOMATIC.

Group 2.

1. Bus bars.
2. Shuttle.
3. Clearing-out magnets.

The apparatus in this group is present in a number equal to 1-10th of the number of subscribers.

MANUAL.

Cords and plugs.

Clearing-out drops or supervision signals.

Same.

AUTOMATIC.

Group 3.

1. Battery and leads therefrom, or dynamo.
2. Operating power.
3. Operating mechanism proper.

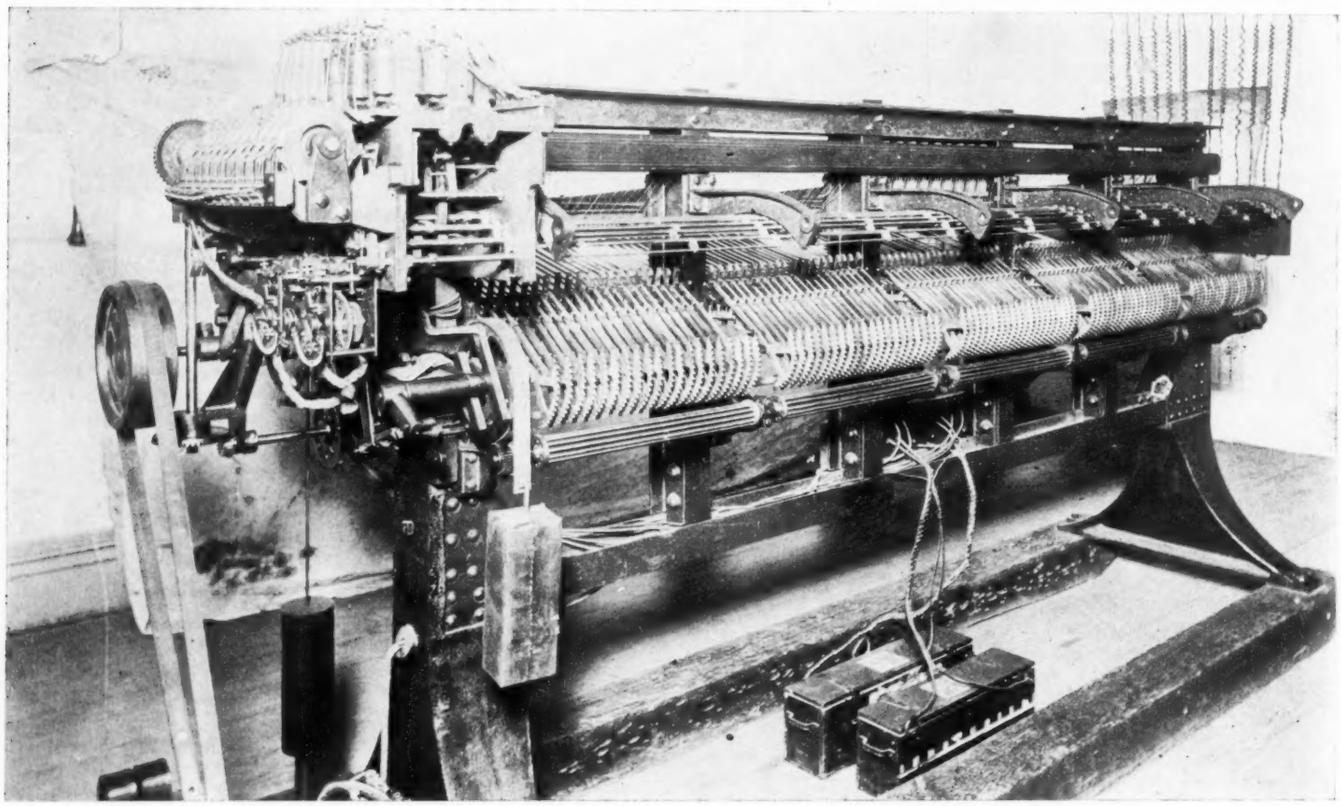


FIG. 1.—THE AUTOMATIC EXCHANGE OPERATOR. (ORIGINAL FORM.)

The apparatus in this group is provided once only per section of 100 lines.

MANUAL.

Same.

These two items are represented by the operator, in a manual exchange.

Same.

DESCRIPTION OF THE AUTOMATIC SYSTEM AND ITS OPERATION.

It is difficult to give a complete technical description of this system without recourse to many numbered drawings, diagrams, photographs, etc.; and those who are specially interested in this subject will find it of great service to witness the actual operation of the system itself, which may seem at the present time in New York City.

This system comprises two separate devices: 1st. A "mechanical telephone operator," situated at the telephone exchange, the original form of this being shown in Fig. (1); 2d. A "sender" or signaling apparatus, as shown in Fig. (2).

THE "SENDER."

Let us first consider the "sender" and its functions. It is preferably placed near each subscriber's telephone, and by its means each and every subscriber is enabled independently to control the mechanical operator at the central exchange. There is no mechanical connection of any kind between the subscriber's instruments and the "sender"; and it can be attached without cutting the circuit; it being only necessary to connect it in parallel across the existing line and to ground. The ground connection is one made for the switching act, when the instruments are idle and during conversation they are free from ground.

The subscriber's "sender" or calling apparatus consists of a small metal box containing a set of disks, numbered on the periphery from 0 to 9—one comprising the units and the other the tens; and in the case of higher numbers being employed additional disks are attached—three disks would give numbers up to 1,000; four disks would give numbers up to 10,000 and five disks up to 250,000. The number of the subscriber to be called is displayed in a line across the "sender" face, and a series of impulses corresponding to this number are sent over the line to the exchange by means of a clockwork started by turning the calling lever projecting from the front of the "sender." This lever upon being turned upwards winds the spring of the clock-work, it then returns to its first position, where it is locked, thus preventing further interference until the call has been sent and properly received at the central exchange. When the "sender" starts the varying series of impulses which are sent over both legs of the metallic circuit simultaneously, the ground (which has been automatically thrown on) is used for a return circuit. The "sender" also contains a magnet whose armature normally retains the clock-work until the magnet is energized by current from the exchange. As in the case of a messenger call or fire alarm box, the calling lever must be turned to its full extent to send a signal, and after this has been done, the protective devices of the "sender," as already stated, keep all the essential parts of the "sender" locked during the dispatch of the signal. When

the switch is completed at the exchange, the subscriber, as well as the party whom he has called, receives a bell signal. There are four of these signals given to called subscribers, covering a period of 30 seconds' time; this period giving the called subscriber time to reach his telephone. As soon as he has taken off the receiver the signals cease and conversation begins.

THE MECHANICAL TELEPHONE OPERATOR.

We will now consider the operator (shown in Fig. 1), and its functions:

All subscribers' circuits are normally free from ground and as already stated, the subscriber's calling device or "sender" is normally open, both as to ground and metallic circuit. In Fig. 3 is shown a diagram of the circuits.

Each subscriber's line terminates in one place only at the exchange—this being a feature not possessed by other automatic systems—each subscriber's line, consisting of two wires, is connected at the exchange to two parallel rods on the mechanical operator.

These rods are insulated from the rest of the machine,

FIG. 2.—SUBSCRIBER'S INSTRUMENT AND SENDER.

which are insulated from each other, but each spring makes an electrical contact with one of the two rods.

The springs on the carriage are adapted to slide by, or at some particular point to make contact with one of a series of bars laid in a grill at right angles to and above the carriage rods.

each pair supporting a carriage, mounted so as to slide on these rods.

This carriage holds the subscriber's terminal springs,

All of the rods or bars employed in the machine are of such dimensions as to have practically no resistance, and the conducting bars and loop circuits connected with them containing impedance coils, and a source of electrical energy, such as a storage battery, and constitute the equivalent of the cord circuit of the manual exchange, and in their functions correspond identically therewith.

While the number of subscriber's terminal carriages is equal to the number of subscriber's lines, the number of cord circuits, or pairs of parallel bars necessary need not be more than 10 per cent of this number, this figure having been found safe in manual exchange practice. There are instances in which boards have had to be equipped with twelve and even sixteen cord circuits per 100 lines, but the average present multiple practice is from seven to ten.

It is never found that all subscribers wish to talk at one and the same time.

When the subscriber's line terminal switch or carriage at the exchange is at a position of rest, one of the subscriber's line terminal springs makes a contact with the ground spring, which is connected to one of a circle of commutator pins. These pins are swept over by a revolving brush attached to the shaft of what is termed the "busy wheel" and which is normally in rotation. There are as many pins on the commutator as there are subscribers, and the revolving brush establishes a connection between a ground spring (subscriber's line) and a battery, operating magnet and ground.

The "busy wheel" to which the commutator brush is attached is driven by a friction clutch from a power device operated preferably by an electric motor, and is arranged to be stopped by a "pawl" and "ratchet" controlled by the operating magnet termed the "starting" magnet, which initially controls the entire switching operation of the exchange. The energizing of the "starting" magnet stops the "busy wheel" and starts the operating gear, which passes through its complete cycle, after which the "busy wheel" is again started, continuing to revolve until the "starting" magnet is again energized.

A second magnet termed the "restarting" magnet is employed to start the "master shaft" going again; in order that the carriage-moving or cord-circuit operating device of the called subscriber may be thrown into gear.

These two "starting" and "restarting" magnets operate in conjunction with the subscriber's "sender" through the medium of a controlling contact apparatus and selector.

The commutator above referred to consists of two sets of circularly disposed contact pins, the number of the pins in each circle representing the number of subscribers.

There are also two metal contact rings, one of which is solid and the other divided into ten equal segments.

The rotating trailer arm attached to the "busy wheel" shaft sweeps over these contacts. The contact pins of one circle are each connected to a separate ground terminal spring; and one of the contact rings is connected in circuit with the "starting" magnet, a battery and ground connection. The purpose of the *contact device* is to prevent any other subscriber from throwing the "starting" magnet into operation while switching is going on. The circuit in this "starting" magnet being always opened, save when the "master shaft" is at its point of rest, each subscriber's line is brought into connection with the ground—once in each revolution, by the revolving contact arm.

The "busy wheel" which has been referred to, consists of a shaft extending through the entire length of the "mechanical operator," which carries mounted upon it and disposed around it in the form of a helix of a single turn, a series of resilient fingers of thin sheet steel, their number corresponding to the number of subscribers.

When the "busy wheel," which is normally running, has been stopped by an impulse sent through the "starting magnet," one of the steel fingers, which is always the one in a perpendicular position, remains resting against the latch holding that particular subscriber's terminal carriage. Next the power mechanism acting through a clutch and cam shoves forward a light shaft termed a "rack," which is studded with pins corresponding to the number of steel fingers and latches, and which runs parallel with the axle of the "busy wheel." As the "rack" moves longitudinally, the upright steel finger is bent over by a rack pin tripping the latch and thus releasing that subscriber's rod and shuttle, which drop into contact with a long lantern pinion; this pinion then rotates through an arc dependent upon the number of subscriber's lines busy at that time. Instantly a lever

engages the two subscriber's shuttles, lifting them up so that their hook heads engage a shuttle detent. There are as many of these detents as there are talking circuits, *i. e.*, one-tenth the number of subscribers (in this machine the number being ten).

A circuit is now established between the springs of the subscriber's carriage and the grid bars representing the cord circuit terminals.

The magneto generator is now thrown on the circuit ringing the bells of both calling and called subscribers. The length of this signal may be varied to suit requirements and is controlled by a timing device. In the meantime the power mechanism has been automatically thrown out of operation and the "busy wheel" again rotates until another call is sent in.

When the subscriber takes his receiver off the hook a multiplying the subscriber's contacts, as in all other systems, and finally, making it entirely practicable to sub-divide the lines into groups of 100, thus keeping the dimensions of the connecting machines within moderate limits.

The act of connecting subscribers consists of three functions, each represented by an independent section of the operator. In the order in which these devices are thrown into use; in establishing a connection, they are termed the "originator," the "pilot," and the "terminator."

The "originator" performs the office of establishing a connection of the calling subscriber's line with the "A" trunk. These "A" trunks are conductors connecting the "originator" and "pilot," and their number represents the maximum number of subscribers which would at any time be simultaneously using the section. It is well to note here that these "A" trunks always have their beginning and end-

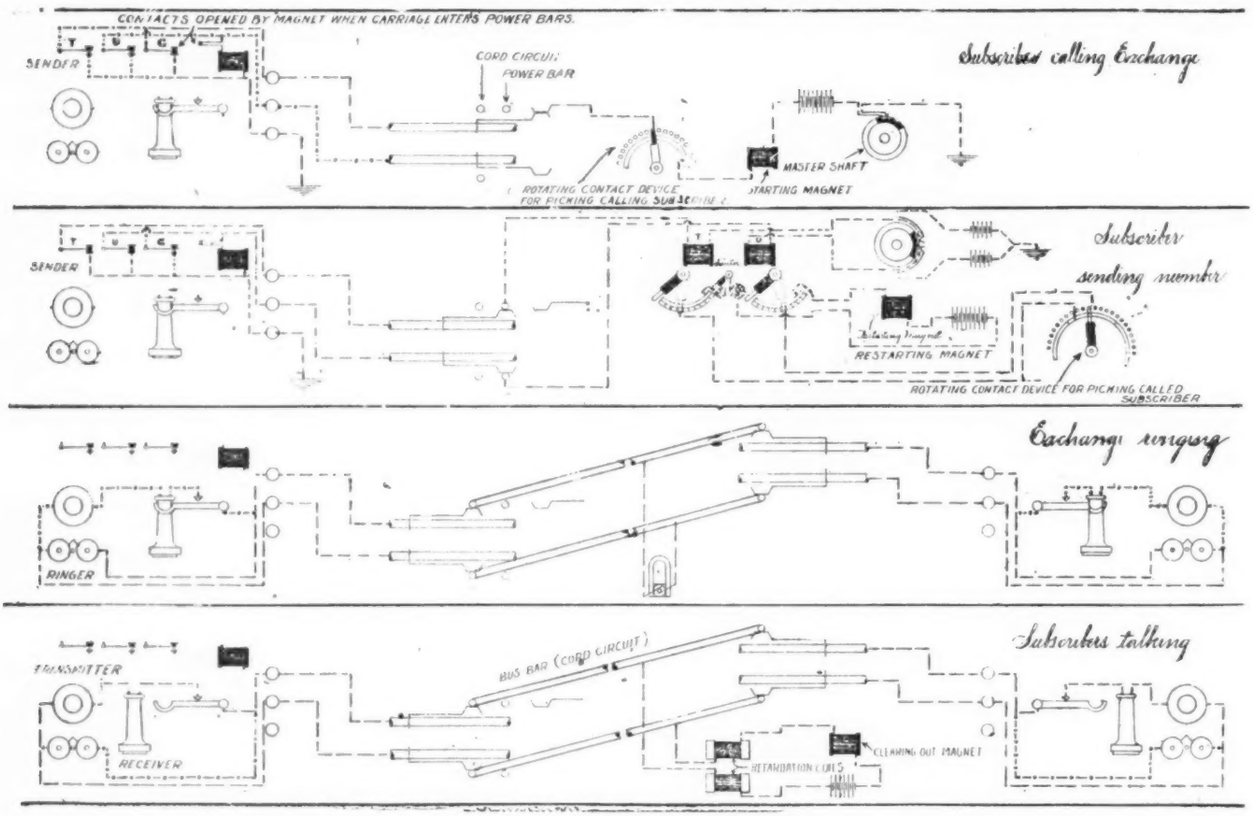


FIG. 3.—DIAGRAMS OF CIRCUITS.

"clearing-out" magnet prevents the switch from clearing out; but when both receivers are hung up, the "clearing-out" magnet becomes de-energized, and its armature causes the shuttles connected to return to their position of rest.

INDIRECT OR TRUNKING SYSTEM.

Up to the present time we have considered the original type of the operator, as illustrated herein, and applicable to small exchanges up to 100 subscribers and employing the so-called direct connection, requiring a single machine accessible periodically to all subscribers. There have recently been made very important changes in the general design of the operator and its mechanical details, without altering the general principles under which the system operates. These changes have greatly increased the speed of making connections, cutting the time down to 3½ or 4 seconds for a trunked connection. The new operator is considerably smaller and lighter in weight, more compact, more "get-at-able," and much cheaper in cost of construction. In this machine also is embodied the indirect or trunking system, applicable to exchanges from 100 up to 250,000 or more subscribers, uniting all, if required, into a single system without sacrificing the plug and cord principle, and without ing in the "originator" and "pilot" of one and the same unit of 100. In this initial act of the "originator," no selective connection controlled from the subscriber's station takes place; but the "A" trunks which are already in use are made inaccessible to subsequent calls, the "originator" always selecting a free and idle "A" trunk. The end of the first free "A" trunk is connected in the "pilot," with a receiver or selector, which immediately upon the establishing of the connection between the "A" trunk and the subscriber's line receives a group-signal referred to later; and thereupon selects a "B" trunk corresponding to the signal received. Immediately the mechanism of the "pilot" connects the "A" trunk and the "B" trunk, at the same time breaking the connection between the "A" trunk and the selector, and putting the selector in connection with the next idle "A" trunk—the "B" trunks referred to connecting the "pilot" and the "terminator."

The ends of all of the "B" trunks, coming from one and the same section of 100, are distributed over all the "terminators" of the exchange, rendering it possible by the aid of one of these "B" trunks to establish a connection between the "pilot" and any one of the "terminators." Here,

again, as many "B" trunks are provided for each "terminator," as are necessitated by the maximum demand for simultaneous conversations between the two groups.

In the "terminator" the first idle "B" trunk is again connected with a selector which, upon the connection of the "B" trunk with the "A" trunk, receives the number signal. Immediately the connecting machinery establishes a contact between the "B" trunks and the contact element in the "terminator," representing the number of the subscriber wanted, which number has been transmitted to it.

Each subscriber, it will be understood, belongs to a certain group of 100, and in this group he possesses a contact element both in the "originator" and "terminator," these being connected to his line in parallel, protective devices being provided by means of which, as soon as the subscriber making a call has caused this particular contact-element in the "originator" to leave its normal position, his corresponding element in the "terminator" becomes inaccessible to other calls, and should any be made they would result in a "busy" signal.

The ringing up of subscribers, conversation and the clearing-out is done in precisely the same manner as in the direct method of connection previously described.

CERTAIN OF THE CONSTRUCTION DETAILS.

The "sender" is identical with that already described and employed upon the original type of the operator. The mechanism at the exchange, as I have already stated, embodies the "originator" "jilot," and "terminator."

The "Originator."—This consists of the switchboard, the movement and clearing-out device.

The switchboard consists of 100 perpendicular tracks, upon which 100 shuttles independently ride up and down. The track rails are insulated from one another, and connect in pairs to the subscribers' lines. The shuttles consist of two metallic parts in contact with the rails, but insulated from each other, each carrying a contact spring, by means of which they may be brought into contact with the "A" trunks.

The "A" trunks in the "originator" consist of horizontal metallic rods placed at right angles to the tracks, enabling

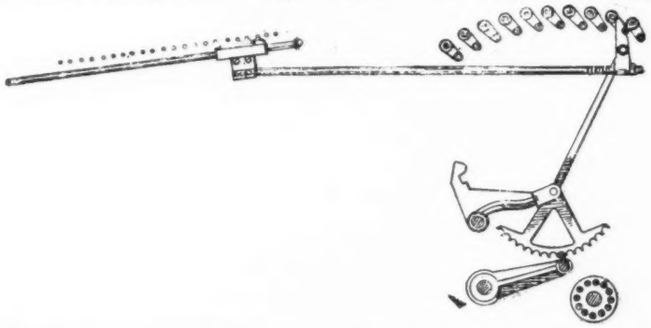


FIG. 4.—SUBSCRIBER'S UNIT, ORIGINAL FORM OF OPERATOR.

each one of the shuttles to be brought into metallic contact with any one of the trunk rods. They are arranged in two parallel vertical planes, one in front of and the other behind the shuttle tracks. The ends of these rods are metalically connected to similarly disposed rods in the "pilot." It is self-evident, therefore, that when a subscriber's line is connected to an "A" trunk this is practically an extension of this line into the "pilot."

Each shuttle is provided with an actuating rod, by means of which it may be operated by motive power. In the position of rest, this rod is supported by a trip which, on being actuated by a magnet, allows the shuttle to drop. This magnet receives the current as soon as the subscriber winds his sender—this act resulting in putting the shuttle into its initial working position. The moment the shuttle reaches this position a projection upon its actuating rod protrudes in the path of a helical projection mounted on a continuously rotating drum, so that the shuttle is carried into its second working position.

The actuating rod cannot be moved further in this direction, owing to a stop in its path; consequently, the drum which is driven by friction is brought to a standstill. The moment this happens, the main mechanism is started, actuating the working beam which extends across the entire switchboard. A projection on this beam seizes the shuttle rod and lifts it into the so-called speaking position, *i. e.*, that in which its springs make contact with the first idle "A" trunk.

On completing its stroke, the working beam returns to

FIG. 5.—SUBSCRIBER'S UNIT, NEW FORM OF TRUNKING OPERATOR.

rest. This stops the connector movement, and the drum driven by friction is again started. The shuttle in the meantime remains in the position in which it was placed. In this position the shuttle actuating-rod rests upon a clearing-out bar, which prevents it from dropping back. There are as many of these clearing-out bars as there are "A" trunks. These have a lateral movement, and when moved they release any shuttles which happen to be suspended from them. How this is accomplished will be referred to later.

At the next call the entire operation is repeated, save that the busy "A" trunk is "jumped" and the next one occupied, and so on.

The "Pilot."—In this we find again the switchboard movement, clearing-out apparatus, and in addition a group signal selector.

The construction of the switchboard is identical with that of the "originator," save that the drum is eliminated, and shuttle actuating-rods pass directly from position of rest into second working position.

The "A" trunks from the "originator" again terminate in rods being provided with a branch circuit to the selector. These branch circuits are normally opened, and are opened during conversation over the trunks, being closed automatically part of the time during the switching act and during the transmission of the group signal.

The shuttles are here connected to rods in the various "terminators," so that the particular shuttle which is select-

ed decides into which groups the subscriber's line will be extended.

The electrical stop motion in the subscriber's sender permits only partial running down of the "sender," but sufficient to transmit that part of the signal corresponding to the first two figures of the number desired. This is the group signal; and after its first transmission the selector in the "pilot" causes the particular shuttle to drop into working position. But immediately the shuttle reaches such a position, the actuating movement is started, and, as already described, establishes connection between the shuttle and that one of the "A" trunks over which the signal came. Thus, the subscriber's line is continued into that one "terminator" in which the subscriber's line which is desired is located; and it now remains to show how the particular line wanted is selected out of the hundred lines in that group. This will be shown in the description of the "terminator."

It is essential to mention here that the circuit, thus far built up, has in it a clearing-out magnet and parallel with that a non-inductive resistance. The province of the former being to maintain the established connection until the conversation is finished. A clearing-out in the "pilot" effects a clearing-out in the "originator."

The "Terminator."—Here we find again the switchboard actuating mechanism, clearing-out mechanism, signal selector, and the ringing apparatus.

The construction of the switchboard is identical with the ones already described, the 100 shuttles forming the terminals of the 100 lines of the group, and the metallic ends of the terminals of the "B" trunk which meet here coming from the different "pilots" where they had their beginning in shuttles.

All these rods have open branch circuits to the selector; but one of these branches at a time is closed temporarily the moment the "pilot" establishes connection between an "A" trunk, and a "B" trunk. Now, the sender is again released, and the transmission is effected. When the signal has been transmitted, the selector at the "terminator" affects the dropping of that one shuttle which carries the number wanted; and if its corresponding shuttle in the "originator" is idle, it is thus connected with a "B" trunk; thereby establishing connection between two subscribers.

In the other case the "busy" signal is given to the "originator," and the connection so far established is taken down.

Next, the ringing machinery is actuated, causing the signal at the called subscriber's instrument—this signal being repeated usually four times. It may be any number.

Should the subscriber not answer, the connection is cleared out, again.

As soon as the subscriber answers, the ringing mechanism is cut out and the talking battery is thrown in, so that no time is lost. On completion of the conversation the clearing-out magnet with its parallel resistance clears the line.

The comparison as to simplicity of operation in trunked calls is evidently still more in favor of this automatic system than even that shown in local calls—as the following comparison of operations necessary—shows.

AUTOMATIC.

1. Subscriber sets "sender" and wind it up.
2. Subscriber's shuttle drops.
3. Subscriber's shuttle is lifted into connection with an "A" trunk.
4. Subscriber's "sender" gives the groups signal.
5. Pilot drops corresponding "B" trunk shuttle, and connects it with "A" trunk.
6. Subscriber's "sender" gives number signal.
7. Terminator drops called shuttle, or, if busy, gives busy signal. Otherwise connects shuttle with "B" trunk.
8. Terminator throws automatic key on called subscriber's line, ringing same.
9. Called subscriber and calling subscriber take off receiver.
10. Automatic key is restored, and talking battery throws on the line.

Next, conversation begins.

Upon its termination:

11. Calling subscriber hangs up.

Clearing-out magnet drops his connection in originator and pilot.

13. Called subscriber hangs up.
14. Clearing-out magnet drops balance of connection.

MANUAL.

1. Subscriber takes off receiver.
2. Subscriber's individual light at exchange lights up, above pilot light.
3. Operator places answering plug.
4. Operator varies listening key.
5. Operator asks number.
6. Subscriber gives number.
7. Operator repeats number.
8. Operator presses order wire key. Gets into communication with the trunk operator in the central office with which the called for subscriber is connected.
9. Operator gives number of subscriber wanted to incoming trunk operator at the second exchange.
10. That operator repeats number.
11. That operator gives number of idle trunk to be selected.
12. First operator releases order wire key.
13. First operator connects idle trunk to her cord circuit, thereby establishing connection between trunk and calling subscriber.
14. Second operator tests called subscriber's line, for busy using the trunk plug.
15. If idle, the operator plugs multiple jack with trunk plug.
16. Second operator presses automatic key.
17. Automatic key rings subscriber.
18. Called subscriber takes off receiver, thereby restoring automatic key.
19. Calling subscriber hangs up receiver.
20. Supervising lamp at first operator's position lights up.
21. Called subscriber hangs up.
22. Second supervising lamp lights up.
23. First operator pulls out plugs.
24. Disconnected lamps at second operator's position light up.
25. Second operator pulls out trunk plug from multiple jack.

SPECIAL CLASSES OF SERVICE.

In modern telephone central exchange practice certain special classes of services are demanded; and these the automatic system already described will take care of in an eminently satisfactory manner; and also adapting itself to the present central energy or common battery system, in a manner impossible with any other automatic exchange.

This system eliminates totally the large force of manual exchange operators, and only in the "toll service" the human operator is for the present essential.

I will consider in turn the manner in which the system would take care of each of these special classes of service.

"Toll Connection."—A special number on the sender will be designated as "toll operator's" number at the exchange, she being called up just as any subscriber is. The operator then asks one what number is wished, and what the number of the calling party is, stating that she will call you when she gets the party you desire. This acts also as a check upon the service, and prevents a dishonest party giving another subscriber's number.

"Restricted Service."—As in manual exchange practice, the toll operator would have a complete list of parties receiving such service, and decline to give any outsider long distance connection until he has been properly identified.

"Appointment Calls."—As in manual exchange practice, these would be made through the toll clerk, who is communicated with through the operator's number on the sender.

"Automatic Pay Station Service."—Such service would require a metering device, preferably a nickel-in-the-slot attachment. The nickel being returned in case no service is rendered. Or a metering device such as a cyclometer, responding to the action of the receiving hook, but *only* when circuits are established or service actually rendered. At the central exchange, a metering device would be operated in conjunction with the "busy test" apparatus, enabling the

operator to check off such service, as in present manual exchange practice.

"Inquiry Calls," "Information Bureau," "Complaints" and "Transmitted Messages."—In addition to the operators in the modern manual exchanges, information men, trouble men, etc., are employed to answer inquiries, attend to complaints and transmit messages. The four classes above mentioned would be attended to in precisely the same manner.

"Party Lines."—A four-party line selective ringing service can easily be given.

ADVANTAGES OF THIS AUTOMATIC SYSTEM OVER OTHERS.

The following points of advantage which are claimed for this automatic system have been investigated by me; and I deem them well worthy of consideration of every telephone engineer.

It is applicable to an exchange of any size.

It is applicable to the present standard central energy system.

It is applicable to any commercial telephone, and to the present arrangements of circuits met with in standard practice.

The total elimination of the multiple principle from this system makes it possible to sub-divide the exchange into several separate local exchanges together forming a large city system, and this without destroying the principle of unity in the system and without decreasing the speed of connection. In this manner a great economy in line construction and maintenance is effected.

It employs the usual protective devices of lightning arrestors, heat coils, etc.

It gives a prompt service, the total time taken to reliably transmit a trunked signal of four figures is about three-fifths of a second, and the average time to secure connection is found to be from three and one-half to four seconds.

It will give a more reliable service, and with equal efficiency at all times. Unlike the human operator it is never impatient or impertinent, and does not become fatigued or ill, and does not drop in efficiency, under stress of the rush hours.

The saving of space occupied by this exchange will be very great, as compared with the space required for a multiple manual system. I am informed that the lowest calculation for space in cities is about a thousand square feet per one thousand subscribers, giving, say, ten thousand square feet per ten thosand line exchange, and this is a *very conservative* estimate. In contrast it is claimed that 100 machines of 100 lines each, with sufficient lane-ways between each machine both ways, of, say, two feet, and a center lane of three feet, would only occupy 62 by 55 feet, or in all three thousand four hundred and ten feet.

It will do away with a large corps of skilled attendants at the switchboards, eliminating one of the heaviest expenses attendant upon the telephone industry.

It will do away with a percentage of employes necessary to keep the central station cables, wires and appliances in condition and lessen the cost of inspection and maintenance.

It is claimed that it can be installed in large and medium sized exchanges, at 30 to 40 per cent less cost than the present multiple exchange system, and that the contacts in, say, a ten thousand exchange would be 80 to 90 per cent less in number than in a multiple exchange. It is possible to add at any time groups of 100 very easily without disturbing the existing installation, and these increase from time to time in proportion to the demand. It would show how much more nearly in a direct ratio an increase in expense of operation and fixed charges with the increase in the number of subscribers, than would be possible with the manual exchange which, as is well known, increases all out of proportion to the increase in the number of subscribers.

It will do away with employes' dressing, dining and reading rooms, clothes lockers, infirmary, matrons, etc., as well as considerable expense for ventilating plant, lighting and other sanitary arrangements necessitated by the usual crowding together of a large number of human operators in modern exchanges.

It permits of a large number of subscribers calling simultaneously, without producing confusion, the calls being stored up and brought into communication with the exchange in numerical rotation.

It requires a single piece of machinery for 100 lines, in contradistinction to the majority of automatic exchange systems, which require one machine to perform the switching for each subscriber's line.

A most important feature is, that it does away with the cords and multiple connections; and as the ground or drop connection is broken when the subscriber's carriage leaves its position of rest, a perfect balance of circuits is ensured, and the absolute isolation of each pair of communicating subscribers.

It gives a continuous trouble test, instantly throwing any line in which trouble has developed, either inside or outside the exchange, into communication with one of the lines, which may be the wire chief's. A permanent record is also made of these troubles.

It requires no batteries and no extra circuits at subscriber's stations, as in all other automatic systems.

It does not necessitate the subscriber's waiting to hear the operator ask "number?" and repeat same to prevent error—thus saving the subscriber's time on each call.

It provides a "sender" which is "fool-proof," it being locked when operating, preventing further interference until signal is sent and properly received at the central exchange.

It does not require extra wiring, or even cutting of subscriber's lines in order to install the sender; there being no mechanical connection of any kind between the subscriber's instrument and the sender; and the sender may be placed at the subscriber's telephone or at any convenient point. It is only necessary to connect it in parallel across the existing line grounding the third binding post of the sender.

It necessitates no multiplicity of idle wires, crowding and complicating the working space, as in other exchanges, which amounts at times to 25 per cent or more.

It requires but a single power driven pulley.

It embodies no parts operating at excessive speeds, in the original type of machine, the driving shaft being run at but 250 revolutions per minute with the operating parts driven by double back gearing at from 12 to 15 revolutions per minute.

It embodies in the mechanism of the original form, but four cams on a single shaft, each acting upon rollers; a single cam controlling all movements, with the exception of the ringing controller. In the new type of "operator," "sun and planet" gears take the place of the four cams in the original "operator."

It employs a single carriage with a connecting rod for each subscriber at central.

It provides a set of metal rods exactly corresponding to the connecting rods of the manual exchange in place of a large number of contacts constituting a multiple of all the lines in the exchange at each "selector," which is a predominant characteristic in all other automatic exchanges. It is substantially built with comparatively few wearing parts, and no telephone cords, plugs and jacks, line drops, lamps, relays, etc., to wear out; the cords being especially troublesome and expensive.

It requires but two operating batteries, no matter what the size of the exchange may be. One battery furnishes current to the switching apparatus, the other for conversation. Some automatic systems employ several batteries at the exchange, and in addition, a local battery at each subscriber's station.

It uses less current than the present multiple boards, as only one per cent of the circuits of the exchange when idle receives any current at all, and that for but a fraction of a second. In some automatic exchange systems the current is very considerable, as compared with the maximum requirements of the exchange.

It makes and breaks every contact by power. No contact in the exchange is made or broken by means of an electro-magnet (on the principle of a relay), not a single relay being employed on the machine.

It can co-operate with manual exchanges, and can call and be called by such exchanges.

It can be completely wired in sections at the factory, with the single exception of the "B" trunks; and at the place of installation it is only necessary to connect the "B" trunks to the "terminator," and to connect each subscriber's line once, a proceeding which is not possible in any installation employing the multiple system. It employs large contact surfaces. It handles all calls, no matter how many subscribers call at once. It possesses a perfectly balanced circuit at all times, having no multiple branches or taps. This is impossible with the manual or with automatic systems generally.

DISADVANTAGES OF THE MANUAL EXCHANGE SYSTEM.

Heavy disbursement for operators' salaries.

Important conversations between subscribers may be listened to by the operator and others at the exchange; and although this is not to be feared to any considerable extent in large exchanges, it is nevertheless a fact that the absolute privacy ensured by the automatic system is highly appreciated by the telephone subscriber. At each call considerable of the subscriber's time is consumed in giving the operator the number desired, and having her repeat the same to prevent mistakes; and frequently the subscriber has to repeat the number several times by reason of his or her indistinct speaking, or standing too far from or too close to the transmitter; or by reason of disturbances on the line, or interference of other sounds in the proximity of the telephone. There may also be interference due to other subscribers being cut in on the lines.

During rush hours it has been necessary at times to station behind the usual operator special operators, who facilitate the handling of the board by pulling out the various plugs. And it is not an uncommon practice when there are troubles at the switchboard, and possibly even during the congestion of the rush hours, for the operator to report a line busy, thus staving off temporarily the calling subscribers. Circumstances have been known where subscribers have been told repeatedly that the party whom they have called was busy; and on his making inquiry at that party's office he has found that the telephone had not been used during that period.

The reason why the multiple board deteriorates faster than the balance of the installation lies in the fact that practically everything has to be sacrificed to considerations of space. A well-known telephone authority in this country has stated that the allowance for depreciation on the switchboard should not be less than 10 per cent; and while the common battery board is doubtless much better than the magneto board, it is believed that with this mechanical operator, with its large surfaces of contact and ample mechanical margins, the depreciation could be much less.

The cost of construction where the multiple section system is employed is enormous. It is a fact well understood by experienced telephone men that, as the number of the subscribers which are connected to any exchange (whether manual or automatic), increases, the expense, both of operation and maintenance, increases in far greater proportion than the increase in the number of subscribers. This is not the case, however, with this automatic system, which, as regards the central exchange expenses and construction expenses and maintenance charges, increases more nearly in a direct proportion with the increase in the number of subscribers.

The length of reach of the human operator in the manual exchange is very limited. She is generally expected to cover a section of board 30 inches each side of her. This is not the case with this mechanical operator, the range of which is practically unlimited. Furthermore, in the latter case, the machine is not delayed by connecting and disconnecting, as it can connect and disconnet at one and the same time, a funtion which is not possible with the human operator.

In considering the disadvantages of automatic exchange systems hitherto invented, it is readily understood why they have met with such limited application up to date, notwithstanding the realization by telephone men the world over, of the many advantages of automatic exchanges; it is because of the inherent delicacy of the various electrical and mechanical devices employed and the rapid depreciation of these devices. It is also due to their extreme complexity, especially in the multiplication in the numbers of wires, contacts, relays, magnets, etc., which increase out of all proportion with the increase in the number of subscribers. It is quite common to employ from five to seven or more magnets and relays in each switching device, and employing one to three of these switching devices in establishing the necessary connections, and utilizing these magnets and relays for performing the actual mechanical work of lifting, rotating and switching the mechanism employed with all the disadvantages which this entails; and finally, it is by reason of the very high class of engineering talent essential in the designing and constructing of the complicated apparatus which has been employed.

It is self-evident to all electrical engineers who have had experience with electro-mechanical devices that it is far better to employ a well-designed mechanism performing a definite cycle of operations and driven by some source of power.

This mechanical operator has been designed and constructed upon the following lines: *i. e.*, an absolutely reliable, prompt, rapid and uniform service in telephone exchanges of any size; an embodiment of all essential features demanded by the exigencies of modern telephone practice; an elimination of the unreliable, flimsy and complex features inherent in systems heretofore presented to the public; and finally, the effecting of large economies in construction and maintenance charges.

The author of this paper believes as a result of his investigations into this system, that these claims made for it will be borne out in actual practice; and he considers it a privilege to be able to present for your consideration what he believes to be one of the most important and interesting inventions ever brought before the American Institute of Electrical Engineers.

The quarantine station of the Marine Hospital Service across the bay on Santa Rosa Island and Pensacola, Fla., will be connected by a telephone system. This fact was made known when the House Committee on Appropriations submitted its report to the House. In this is an item of $14,000 for the improvement of the local quarantine station, which was recently purchased by the government from the state for $20,000. The fact that there will be telephone connection between the two points, which will necessarily be through a cable, caused much rejoicing in Pensacola, as the present system is very inconvenient to shippers and others interested in the arrival of vessels, who would either be compelled to hunt up tow boat captains or pilots to find out the names of vessels arriving at the station, or else wait until the following day for the quarantine officers' reports to be sent over by a launch.

The Necessity of Uniformity

Mr. President and Gentlemen of the Convention:

An element of the Independent telephone movement depends in particular upon this element, which at the present time is surprisingly lacking.

There is no business on earth with which to compare telephony. Independent companies are formed and exchanges built up by local communities, but the thousand and one companies so formed soon become linked together by ties which bind the companies together more closely than the marriage rites bind husband and wife. When discord disturbs the relations of the latter, relief may sometimes be found in the courts and more congenial alliances are sometimes formed. But with telephone companies,

"All are parts of one stupendous whole,"

and when they disagree the only relief lies in correcting the causes of the troubles.

The lack of harmony is due to several causes, all of which may be easily eliminated. Your attention is therefore called to a few of those causes and suggestions made for their removal, as follows:

Selecting a Field—The world is large, the United States is large, and Wisconsin is large. The telephone industry is but in its infancy, and it would seem that there should be no rivalry and no attempted competition between Independent companies. But many instances do occur where rival Independent telephone companies seek to control the same territory. Let such rivalry be stopped. If the question of priority of occupation of a particular territory cannot be settled by mutual agreement, submit the disputed question to the executive committee of the state association and abide by its decision. That work is one of the specific duties imposed upon the executive committee of this association and one of the objects of this association is to promote harmony.

Construction Work—Many companies whose lines and exchanges are well and properly constructed and equipped with efficient and up-to-date apparatus, suffer immeasurably, and incur the displeasure of the public by connecting with a company whose construction is such as to make it unfit for long distance service. See to it that your construction work is of the best, for the best is none too good, and let it be done under the supervision of competent men. It is not always necessary to employ a high-priced engineer, but it is necessary that the man who has charge of your construction work, whether he be a professional, or an every day trouble man, should understand the work entrusted to him, and one who will permit none but up-to-date methods to be used.

One of the most serious faults in construction and one of the most costly causes of trouble in operating is the imperfect, weak and inefficient methods of guying poles and this applies to toll lines and exchanges alike.

Let this association adopt a uniform system of construction, in which shall be taken into consideration the number of poles per mile, the soil in which set, the number and length of cross arms to be carried, the number of wires and cables to be supported, and the size and number of guys to be used, and then let every company in the state use only the standard system. With taut wires, short circuits, except from foreign substances, and breakages of wires will be of rare occurrence which will avoid ninety per cent of line troubles.

As to the apparatus to be used, whether telephones or switchboards, use only the best. It is sometimes difficult to decide which is the best among the numerous types upon the market, but in making your selection, make it from such apparatus as will stand the test of long distance work. No matter how purely local may be the service required of your exchange at first, the date is not far distant when long distance service will be required, and then, woe to the exchange equipped with instruments capable of transmitting but a few miles.

In the use of wires for toll line work, there is a sad deficiency in Wisconsin of copper wires, which fact alone places the state far in the background with our sister states, though the number of Independent subscribers bear about the same proportion to the population. I know that many companies have equipped their lines for through copper circuits, but the wire is still lacking.

Operating—It is in the operating department that the company comes into direct contact with the public and here the question of the proper charges to make for tolls and rentals is a serious one.

The Independent companies have taken the telephone from its high and mighty place among the luxuries of life and brought it to the level of the necessities of home and the office, and what enabled them to accomplish this great work was the fact that they made prices within the reach of the masses. But in doing so they were soon confronted with a condition little dreamed of.

A city of 20,000 population might support an exchange of 200 instruments under the old Bell rates of $3 and $4 per month rentals and make enormous profits for the Bell company. The Independent company would install an exchange in the same city and fix the rate at from thirty-three per cent to fifty per cent less than the Bell rates and for an exchange of equal size would make large profits; but the reduced prices brought increased patronage, and instead of supplying a subscriber with only 200 connections the company was soon called upon to furnish 500, 1,000 and even 1,500 connections at the cheap rate, whereas the Bell company under its high prices was limited in the service required to 200 telephones.

Now, while it is possible to make good profits on the investment necessary to equip an exchange for 100 telephones in a small place at a monthly rental of $1 per month, and a proportionately larger profit for ten small exchanges of 100 subscribers each, yet to combine those exchanges into a city exchange of 1,000 subscribers and charge but one dollar per month would bankrupt any company in a short time, and yet the public, without appreciating that increased connections makes a telephone more valuable, look upon the telephone business in the same light that it does an ordinary commercial transaction and reasons that if a company can make money at a certain rate for 200 connections it should be able to furnish 1,000 or 1,500 connections at a much cheaper rate while every exchange manager knows that it is just the reverse.

It is currently reported that our present state legislature will enact laws at its present session fixing the maximum rates that may be charged for rentals in cities, according to population. Such a law would be unfair and should be avoided if possible. If a law is to be enacted at all it should be based upon the number of subscribers to an exchange rather than the population of the city, for it is the size of the exchange and not the size of the city which governs the cost. And in any event there should be a uniform sys-

*Abstract of paper read by A. L. Hutchinson before the Independent Telephone Association of Wisconsin, Feb. 11 and 12, 1903.

tem of fixing rentals by companies in this state so that subscribers who are paying but a fair rate will not think they are being robbed because the subscribers of some neighboring exchange have been given a rate lower than is consistent with good business management. An attempt was made at the June meeting of this association to adopt a schedule of toll rates for connecting companies and a basis for a division of the fees among the companies so that every company which contributed to the transmission of a message should receive its just proportion of the fees earned.

The schedule adopted should have been put into effect by every member of this association, but it was not, and it is a fact that one of the officers of this association who was a member of the committee which formulated the schedule and signed the report recommending its adoption, afterwards flatly refused to have the exchange controlled by him put those rates and the basis of division of fees into effect, and arbitrarily demanded that he be allowed to receive the fees formerly allowed him, or that he be paid ten cents per message for every message coming into his exchange. That the schedule adopted is not perfect is conceded, but it was an attempt at uniformity, and the quickest way to perfect the schedule was to put it into effect by all companies.

The Interstate association, at its convention held last December, adopted a resolution directing the executive committee and secretary to prepare a uniform schedule and basis of division of fees and recommend it for adoption to all the state and district associations in the Interstate territory. As soon as the committee has completed its work the schedule will be submitted and should be adopted as far as possible. It will not apply to messages transmitted over the wires of a single company exclusively, but will apply to all messages transmitted over the wires of two or more companies. In this connection I would recommend that the executive committee of this association be authorized to receive and pass upon that schedule when received by the secretary of this association, and that it be made a part of their duties to see that the same goes into effect among the various companies in Wisconsin. It may not, and probably will not, be perfect, but it will be a step in the right direction and any imperfections can be corrected at the next Interstate convention.

The state and Interstate association have great responsibilities and much work to perform, and much good can be obtained by operating companies by attending and taking part in their conventions, and a better understanding can be had as to what is needed to create more uniform methods in construction and operating. And right here I wish to call the attention of every man interested in telephony, whether he be a manufacturer, an operator or a promoter, to the fact that the good work which ought to be accomplished by these conventions is largely lost by failure of those in attendance to be present and take part in the discussion of important questions as they come up in the convention. And I further wish to call the attention of manufacturers and salesmen in a friendly way that they are in a measure responsible for this state of affairs. I know it is hard for the man who makes apparatus to resist the temptation of occupying every moment of time of a prospective purchaser, but he should bear in mind that the object of the conventions are not solely for him to sell his wares, but to benefit the operators, and the mere knowledge gained by the operators, the more perfect will their systems become, the higher will be the state of Independent telephony, and the better will be the field for the manufacturer to do business in. It should be the duty of every exhibitor at any convention to insist that all exhibits should be closed to visitors during the hours the conventions are in session, and to insist that the delegates who attend and who in nine cases out of ten are paid their expenses by the companies they represent for attending, should take part in the work of the conventions. If this is done it will redound to the exhibitor's benefit in the end, and we shall accomplish more in the way of actual improvements in our methods of construction work and systems of operating than we have accomplished in the past.

A WOMAN AT THE TELEPHONE.

BY A. H. E.

"'What number?' Well, Central, it's about time you answered. I've been standing here ten minutes at the very least! 'It couldn't have been more than one,' you say; it seems to me I ought to know more about the length of time I've been here than you, since I'm the one who's been waiting. Well, we won't discuss it, I'm sure! I want Black 4265, please. What's that? 'There is no such number?' Why, I think you *must* be mistaken; I have called for it every day for months and ought to be sure of it. I'm perfectly willing to look it up again, certainly; there's no need of being saucy about it! Yes, I knew I was right, it is just as I said: White 4265! I said 'Black 4265?' I think you misunderstood me. Well, never mind (wearily), give me *White* 4265 now, please. You 'can't get them,' you say! I'm sure they're there; can't you ring louder? Probably they are down stairs and don't hear you. Well, won't you call me up when you can get them, as it's quite important, and, Central, what time is it please? My watch stopped this morning. I think I must have forgotten to wind it last night, and I want to get the correct time. To the second, if you please, and, wait—I'll write it down so that I can set my watch exactly later. Thank you, and you won't forget to call me up as soon as you can get my number?"

A few minutes later the bell rings furiously. "Yes, yes, I'm coming; don't ring the telephone down. Hello, hello! I say why doesn't some one answer? Is this Central? 'What number do I want?' Why, I didn't call you, our bell rang and I thought, very naturally, that some one must want us. 'What's *our* number?' M 236. 'Wait a minute?' That's what I am doing, it seems to me. 'It must have been a mistake,' you say. Well, I don't see how a bell can ring like that by mistake, but now that I'm here, won't you try to get White 4265 for me again? Yes, it's the Smiths, on Kane Place, all right—pardon me, this line is in use—er—excuse me, you can't get Central now, *I* am using the line. Will you hang up your receiver, please, as I am trying to get a number? No, this isn't Central, it is some one using the line. Yes, I know these party lines are a nuisance; no one appreciates it more than I do at this instant. 'You've been trying to get Central for the last half hour!' Well, that isn't my fault. I'm sorry, but so have I, and she is at last getting my number for me, so if you'll hang up pl—— Well, of all the impudent things, I'm sure it isn't my fault that he's been standing there all the morning. Hello, Central! 'Did I get them?' Why, you ought to know whether I did or not, as well as I, I should think. No, I didn't. 'The line was busy last time you tried,' did you say? Well, I don't see to whom they can be talking at this time of the morning. I think you must be mistaken. Won't you ring them up once more? What's that! 'There they are?' Well, thank goodness! Hello, dear, I had the worst t——, Oh! I *beg* your pardon. Isn't this White 4265? 'It's White 4264,' did you say? Do excuse me, it's Central's mistake. I am *so* sorry to have disturbed you. I know how a man hates to be called from his work unnecessarily. What? Oh, you're very kind to say so, but I'm *sure* I did. Will you hang up now, please, and I'll try to get Central to give me the right number. Thank you. Good bye.

"Hello, Central! You gave me the wrong number. I want White 4265, not 64! Why, no; I said 65 at first, I am sure. Perhaps you'd better give me the chief operator; she may be able to get me what I want."

I thought that would silence her. Mercy! I could have gone down to Mabel's in a shorter time than it's taken me to telephone her.

At last!

"Hello! Is this White 4265? Yes; and is this Miss Smith? Well, good morning, my dear. I wanted to be very sure it was you before I spoke too affectionately, as I have had one experience this morning with a man whom I called 'my dear' by mistake, and I thought I wouldn't repeat it. How are you? That's good. I've had the worst time getting you that can be imagined. What? You've been right there all the time and not using the telephone? Well, I *told* Central just that exactly. I've a good mind to report her. What? Yours is a party line and some one else might have been using it? Well, that's true, of course, but she might have explained instead of being so impudent. Well, say, Mabel, have you got the recipe for those pickles I had at your house the other night? They were so good I want to make some, for I know George would just love them. You have it, you say? Would it be too much to ask you to give it to me now? I think I'll have my girl make some this week and I'd like to have the recipe ready. Yes, I'll hold the line. I'm sorry to make you go way down stairs.

"No, Central, of course I'm not through. I'd hang up if I were. I'm holding the line, please. Yes, hello! This you again, Mabel? All right, just a minute while I get my pencil and paper. Now I'm ready. * * * Mercy! does it take as much vinegar as that? You have to soak them over night, you say? That's a nuisance, isn't it? Yes, I suppose it does improve them. 'Spice with cloves and cinnamon,' thank you so much. Now, won't you read it all over so that I can be sure I have it right? All ready; yes, yes, yes, that is just as I have it. I'll try them. Well, of all the rude things; that woman is certainly very anxious to cut us off. One has a right to use her own telephone as long as she wishes, I should think, and we haven't been talking long, anyway. What's that? You may come up to-day? Do! I'd love to have you come this morning and stay to lunch, can't you? All right, be very glad to have you. What? That's true, I might have let you bring it to me, but I didn't want you to have to bother to write it out. See you at eleven, then. Good-bye."

A GROUP OF PROMINENT INDEPENDENT TELEPHONE MEN.

From left to right, standing: J. E. Keelyn, W. F. Goodrich, A. E. Barker, A. S. Munsell, L. W. Stanton, J. A. Russell, H. M. Rounce, C. F. Speed, J. H. Montague, M. W. Zabel, John Stone, Jack Johnson.
From left to right, sitting: L. G. Bowman, I. H. Moulton, C. A. Sterling, A. J. Rousseau, W. E. Doolittle, R. M. Abbott.
From left to right, foreground: G. L. Ainsworth, M. I. Berger, R. H. Manson.

MANUFACTURERS' SECTION

INTERNATIONAL TELEPHONE PARTS.

One of the most neatly and scientifically designed and durably constructed line of telephone parts that has been evolved is that being put on the market by the International Telephone Manufacturing Company of Chicago.

The International company makes every part of the equipment from the crude material, under its own supervision, with special tools and machinery of the latest and most improved pattern. Every part being made by machinery with a special tool or die, makes all like parts perfectly uniform and interchangeable at all times.

The transmitter arm shown in Fig. 1 is hinged to its base with a large surface friction hinge clamped by a heavy bolt and nut. The base is provided with a sub-base to which it is fastened with a pair of heavy, nickle-plated brass binding machine screws. The sub-base may be permanently fastened to the backboard of an instrument. The cords and wire terminals are mounted on an insulating block which is fastened to the sub-base. This arrangement enables one to take off the arm for inspection or testing, without taking the screws out of the wood, causing no necessity for injuring the back-board and also avoiding unsoldering or splicing wires when removing the arm. The arm and base are made from light gray iron castings, smoothly finished and heavily japanned. The arm is hollowed so that the two cords for the transmitting circuit may pass through it and be concealed. The binding bolt and nut is made from hard brass and is heavily nickle-plated. It is provided with a neatly designed, large, close-fitting head to make it strong and reliable.

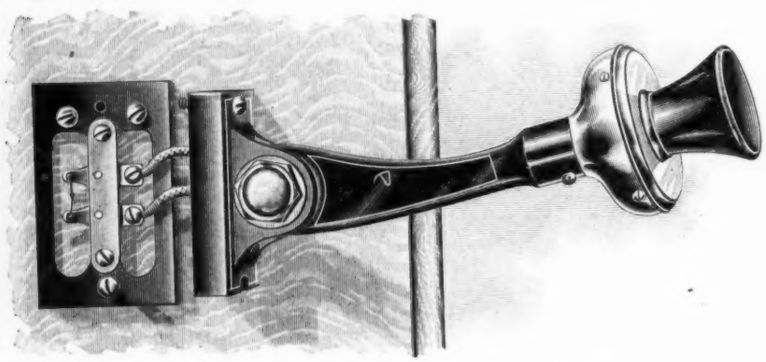


FIG. 1.

The International transmitter, shown in Figs. 2 and 3, is claimed to be one of the best and most carefully made transmitters now in use. The case is a little less than three inches in diameter and is properly proportioned and neat in design. The front is a heavy, nickle-plated brass casting on which are rigidly mounted all the working parts. The diaphragm is a flat metal disc and is provided with a rubber band around its edge to perfectly insulate it from the frame. The diaphragm is firmly clamped by two fork-shaped springs holding it evenly at four points, leaving the diaphragm with the greatest possible freedom for vibrating. The carbon chamber is a very light metal cup mounted on the center of the diaphragm. The front electrode is spun into the bottom of the cup, permitting no room for the granules to settle under its edge. The back electrode is mounted on a brass stud which is provided with a washer and nut to firmly clamp a mica ring. The outside of the mica ring is clamped by a rim of the light metal carbon chamber, perfectly sealing the chamber. The back electrode stud is set into a clamping device that is made in the form of a spring collar, allowing the electrode to be moved the slightest degree for adjusting and so it can be firmly clamped without disturbing the adjustment. This adjustment clamping device is so arranged that it holds the electrode perfectly central with the diaphragm, and obviates any indentation or side strain which usually occurs from the side set screw. The adjusting device is set into a heavy, squarely-formed brass bridge, from which it is properly insulated with hard rubber bushing and mica insulation. It is constructed very rigidly to avoid all possibility of throwing the instrument out of adjustment from heavy strains. The circuit from the front electrode is taken from the diaphragm to an insulated block, mounted on one side of the bridge, and the circuit from the back electrode is taken from the back electrode stud to an insulated block on the other side of the bridge. These conductors are of light metal punchings, properly formed to make rigid and durable connections, without being required to solder any joints of delicate wires. Both sides of the circuit are taken from the two terminals by insulated cord, through the arm to the terminal or induction coil, avoiding the use of any exposed parts of the transmitter frame or arm for any part of the circuit. Every detail part of this instrument is made by a special compound sub-die to make all like parts absolutely uniform so that the instrument can be assembled without filing any part for fitting. Any part becoming accidently broken at

CABLES.

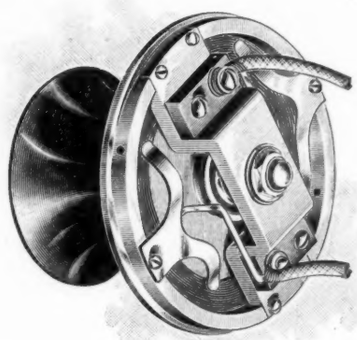


FIG. 3.

any time can be readily replaced without returning the entire transmitter to the factory. The electrodes are of extra hard carbon, highly polished and the granules are clean, hard granular carbon. The diaphragm is placed under the proper tension and the cup vibrates with the diaphragm, which keeps the granules agitated and "alive" at all times, which is said to absolutely prevent packing.

The International receiver, shown in Figs. 4 and 5, is claimed to combine the most practical ideas and essential features of an instrument of its kind. It is neat in appearance, efficient in its working and has every detail part sub-

FIG. 4.

stantially constructed. It has a horse-shoe magnet, constructed in one piece, of the very best magnet steel obtainable for the purpose, and of sufficient length and weight to secure the strongest magnet possible for an instrument of its kind. It is fitted at its pole ends into the adjusting block and firmly clamped to the bobbins and block by a heavy binding bolt and nut. The diaphragm is firmly clamped to a metal head by a threaded metal ring, to give it the greatest possible freedom to vibrate so it does not depend on the rubber cap for its permanency. Its double pole pieces are made of a special grade of soft Norway iron, thoroughly insulated and wound with silk-covered magnet wire. The cores are swedged under heavy pressure in a special die, to make them absolutely uniform in width and to provide positive stops for the spool heads. The ends are milled perfectly square in a special jig, making them all of one length. The spool heads are mounted and set to the core by machine in a special tool to give the bobbins all the same spacing. The spools all being of one shape and size in every way, makes them interchangeable at all times. The cores fit tightly into the adjusting block, making it impossible for the receiver to get out of adjustment. It is adjustable so that the diaphragm and pole pieces of every instrument may be placed in their exact, proper relation with each other, to secure the best possible results for the service desired. The spools, being practically the only working parts of a receiver that are subject to being destroyed or naturally becoming defective, are made adjustable so this part may be conveniently and readily replaced, and the receiver accurately and permanently adjusted without returning the entire instrument to the factory. It has all working parts self-contained and has no part depending on the shell or cap for being held in place. Its magnet is fastened at the pole end only, so the receiver is not affected by the great difference between the contraction and expansion of the rubber shell, and of the magnet steel, from extreme variations in temperature. The magnet, and the spools, are securely fastened into a strong cast brass-threaded adjusting block. The adjusting block is adjustably fastened into a metal cup. The diaphragm is clamped firmly to the edge of this cup by a finely threaded metal rim. The adjustment is locked by two binding screws passing through slots in the cup, firmly clamping it to the adjusting block. All working parts being of metal and securely held in position near the diaphragm, makes the adjustment absolutely unchangeable. Every detail part is made strong and durable. The shell, which in itself is of extra thickness, has no strain or weight to hold, being only a cover to the working parts. The receiver can be used without its shell. The cap of the receiver is provided with a small ridge around the hole so that perspiration, due to long use of the instrument in hot weather, will not enter and rust the diaphragm. The shell and cap are constructed of the highest grade of polished hard rubber. The coil wires are of the best quality silk-covered magnet wire and lead through sleeving direct to the cord terminals, avoiding all possible chance of loose connections or open circuit in the receiver head. The cord terminals are placed between the magnet bars. They are provided with a special cord clip to hold the cord by its braid and relieve the conductors of all strain. The outer ends of the cord are regularly furnished with a loop to fasten under a binding screw. They are provided with

FIG. 5.

the ordinary cord tips if desired and so ordered. The receiver has all metal parts an cord terminals entirely concealed within its rubber shell and cap. It is claimed there is no danger of getting an electrical shock from the receiver while using the instrument, in case of lightning or trolley crosses on the outside lines.

The International company is making a specialty of telephone apparatus of the very highest grade possible, for the complete equipment of large and small exchanges, long distance toll lines and heavily loaded country party lines.

SHE'LL HAVE TO THINK UP ANOTHER.

"Do you think the time will ever come when we can telephone without wires?"

"I don't know. If it does, I wonder what excuse the girl at the exchange will have to make when she prefers to have us ring up again?"—*Exchange.*

TRADE NOTES

HIPWELL MANUFACTURING COMPANY, Allegheney, Pa., is sending out a very clever folder in the shape of a bank book. The folder describes the Hipwell apparatus and is printed in color.

THE IOWA PAINT MANUFACTURING COMPANY, Fort Dodge, Iowa, will be pleased to send to prospective buyers sample cards of the different colors and grades of paint it manufactures.

THE ELECTRIC APPLIANCE COMPANY, Chicago, has published a little folder describing the Noxem receiver which, together with the company's complete catalogue, will be sent to any address prepaid.

THE STATE TELEPHONE CLEARING COMPANY, Weyauwega, Wis., has recently issued a book on a clearing house for telephone messages. The book is well worth reading and the company is doing a much needed work.

THE ELECTRIC APPLIANCE COMPANY, Chicago, is sending out a folder describing the 1900 dry battery, showing a cut of the battery and giving a full description. A number of testimonial letters are reproduced.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester and Chicago, has recently issued a folder describing a reliable out-door telephone for interurban railway lines, lumber camps, mines, police service, etc.

KELLEY-BURTON ELECTRIC COMPANY, Cincinnati, Ohio, has recently issued a little book entitled "Telephone talk," which tells all about the apparatus manufactured by this company. The book is well written and will be found of considerable interest.

THE GREEN TELEPHONE AND ELECTRIC MANUFACTURING COMPANY, Milwaukee, Wis., is sending to prospective buyers a booklet illustrating and describing the company's line of telephone apparatus. Especial attention is called to the Green solid back transmitter.

BAKER AND COMPANY, Newark, N. J., have just issued the tenth edition of their pamphlet on Platinum, which contains some fifty-six pages, is fully illustrated and is complete hand-book of information. The booklet will be mailed free, postpaid, if this publication is named.

PONTIAC ENGRAVING AND PUBLISHING COMPANY, Chicago, has recently issued a booklet showing specimens of engraving of telephone apparatus, both in half-tone and wood. The work is high class in every particular. The booklet will be sent postpaid to any address upon request.

FREDERICK PEARCE, 18 Rose street, New York, has just been awarded the contract to construct the new fire alarm telegraph system on Staten Island. One hundred and eighty miles of wire will be used. Mr. Pearce has just issued a very handsome catalogue of nearly 400 pages showing the various instruments made by him as well as a full line of electrical supplies.

FISK-NEWHALL TELEPHONE MANUFACTURING COMPANY, Chicago, has just issued its first catalogue of its complete line of apparatus. The catalogue is one of the most finely illustrated books published by any telephone manufacturing concern, and fully describes the Fisk-Newhall telephones, switchboards and accessories. It will be mailed free to any address upon request.

THE CENTRAL ELECTRIC COMPANY, Chicago, is distributing to the trade a pamphlet of the Alphs and Omega Toggles, two new devices for which there is sure to be a large demand. These toggles are strong, well made and low-priced. The pamphlet also contains a description of the new Zero solderless lug. Buyers of this material would do well to obtain a copy of the pamphlet.

THE CHICAGO TELEPHONE SUPPLY COMPANY, Elkhart, Indiana, has just issued an attractive folder on the "Correct principles of generator construction." This company has made a specialty of bridging telephones for a number of years, and claims that its success is largely due to the Chicago method of generator construction, which differs radially from that employed by other factories.

THE STANDARD TELEPHONE AND ELECTRIC COMPANY, Madison, Wis., reports that orders received for all lines of telephone apparatus have been exceptionally heavy during January and February, making it necessary to increase the factory force. Orders for the new Standard solid back long distance transmitter are good, with indications that the company's spring business will exceed all previous years.

THE ECCLESTON LUMBER COMPANY, 29 Broadway, New York City, announces that it has on hand a larger number of seasoned poles and lumber for electric line construction work than at any period in its history. This is in order to supply the greatly increased demand for this company's material. The company plans to further increase its stock facilities in order to anticipate several heavy contracts which are about to be closed.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, of Chicago, reports the following among recent contracts closed: Calhoun County Telephone Company, Kampsville, Ill.; Kilburn Telephone Company, Kilburn, Ill.; Mutual Telephone Company, Strasburg, Ill.; Secor Telephone Company, Secor, Ill., and Danforth Telephone Company, Danforth, Ill. The above contracts are all in Illinois and are for telephones and switchboards.

THE ACME ELECTRIC COMPANY, Chicago, has just issued a catalogue of its complete line of telephone equipment and accessories. It is fully illustrated and gives much valuable information on the material to be used in line construction, installing bridging apparatus and telephone troubles. The Walsh fable in the front of the catalogue and the philosophy on the different pages is particularly good. The catalogue is well worth reading and will be sent free if TELEPHONY is mentioned.

THE HOLTZER-CABOT ELECTRIC COMPANY, Brookline, Mass., has issued an attractive 1903 calendar. Instead of containing the usual more-or-less decorative picture, a fine illustration in colors of the Holtzer-Cabot 1903 factory appears at the top. The work is well executed and a bit of harmonious coloring is the result. The calendar pad itself is a combination of brown and yellow and the entire production seems to have been planned for continuous utility rather than impressive gaudiness.

THE CHICAGO TELEPHONE SUPPLY COMPANY, Elkhart, Indiana, reports larger sales during the first two months of this year than at any similar period previously. This large increase in business the company attributes to the pop-

ularity of the Chicago 1903 transmitter. The company is running its factory twenty-two hours out of every twenty-four. A recent shipment of Chicago apparatus was to Teixera and Sodre, Jahu, Saa Paula, Brazil, for the equipment of several Brazilian exchanges.

THE AUTOMATIC ELECTRIC COMPANY of Chicago, has recently shipped to the Mutual Automatic Telephone Company, Albuquerque, New Mexico, a switchboard of 1,000 ultimate capacity with 400 telephones and switches for present installation. The city of Albuquerque has had automatic telephone service for seven years, the local company having purchased one of the early types of Strowger switchboards. The new equipment was purchased to meet the demand for service beyond the capacity of the switchboard which has been in use.

THE MANHATTAN ELECTRICAL SUPPLY COMPANY, New York and Chicago, has just issued its catalogue No. 14, and also the pricelist applying to this catalogue. The Manhattan company's catalogue is a liberal education on the electrical supplies necessary for electric light, household, telephone, telegraph and railway equipments. The illustrations are all clearly printed, and the descriptions are comprehensive and easily understood. The book is supplemented by a carefully prepared index, and is very valuable to the practising electrician.

THE STANDARD POLE & TIE COMPANY, of 135 Front street, New York, has completed work on its crossarm mill at Brooksville, Florida, which is situated in Hernando county in the center of the Florida heart pine belt. The mill has a capacity of 40,000 feet per day, and is equipped to turn out arms of any dimension and bore. Shipments have already been made and the company is in excellent position to fill all orders and make prompt shipment to any point. All arms turned out are subjected to careful inspection before shipment, and upon request samples will gladly be furnished.

THE AMERICAN ELECTRIC FUSE COMPANY, New York, Chicago and Atlanta, is mailing out an envelope marked 6,583,741, which figures represent the number of American connectors sold by the company during 1902. Directions for using the connectors are given as follows:

A simple twist by a good strong wrist,
Three times around the wires;
The joint is made with but the aid
Of ordinary pliers.

A sample of the American connector is enclosed. The company announces its new prices as being very low.

T. H. BULLOCK & Co., Chicago, purchasing and forwarding agents for the electrical trade, are now nicely located in the Medinah Temple. Both T. H. Bullock and L. G. LeBourveau are well known to the telephone trade as energetic, hustling business men who are thoroughly familiar with every detail in the operation and manufacture of telephone apparatus. They are already doing the purchasing for a number of telephone companies and claim their attractive money-saving proposition is helping earn dividends for their customers. Correspondence is invited and a trial order solicited.

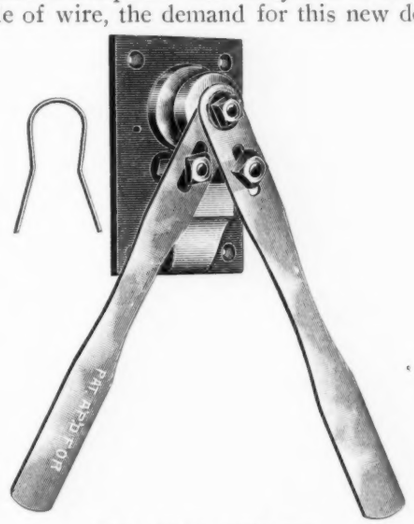
THE INTERNATIONAL TELEPHONE MANUFACTURING COMPANY, of Chicago, is having a heavy demand for its generator-call telephone for long distance toll line and heavily loaded country party line use. The International instrument is especially adapted for this class of work, it being equipped with a powerful generator of extra heavy output; adjustable ringer; far-reaching, clear and distinct transmitter; double-pole horse-shoe magnet, adjustable receiver and having all connecting wires, binding posts, terminal screws, etc., concealed and no exposed metal parts forming any part of the circuit. This make of telephones is one of the most accurately constructed, most efficient and durable line of instruments produced.

G. M. GEST, New York and Cincinnati, has been more than usually successful in securing a number of large contracts for conduit construction this past season. The Gest conduits are now being equipped with the conduit terminal for finishing in a very complete manner manholes and conduit ends. The Gest conduit terminal is so shaped that the conduit end butts into a flange deep enough to afford a snug fit, the outside of the terminal being flared so as to receive a deep bedding of cement, so that the brick course can come up flush with the face of the terminal. These terminals are made either of cast iron, with enameled surfaces, or of glass or porcelain. Descriptive circulars will be sent on request to any one interested.

THE STUART-HOWLAND COMPANY, Winthrop Square, and 261 Devonshire street, Boston, has for several weeks been making alterations, erecting offices, shelving, etc., in its enlarged quarters, and its store and offices are now a model of neatness and convenience, the equal of which would be hard to find. Everything is arranged for the quickest possible handling of goods and at a minimum of cost. There are three elevators, which are kept active, and in addition, two immense slides for receiving heavy goods in the basement. The store has a frontage of about 60 feet on Winthrop square and about 200 feet on Devonshire street. Judging from the activity of the shippers, and the quantities of goods on the sidewalks awaiting draymen, the business of this enterprising firm promises soon to outgrow its enlarged facilities.

ONLY TIE-WIRE FORMER.

The Tie Wire Former, manufactured by the Only Manufacturing Company, Moravia, Iowa, is made in a very substantial manner, the base being cast of iron in one solid piece, the handle cut from bar iron. During the past the telephone and telegraph companies have bent the wire by hand. With this machine the necessity of this is obviated and as the above companies use thirty-five to forty tie wires to each mile of wire, the demand for this new device is apparent. In the state of Iowa alone there is nearly thirty-two million miles of wire. Allowing thirty-five joints to the mile it would require something over a billion tie-wire formers. This new appliance, cut of which is hereby shown, is for sale by all the leading supply houses in the United States.



THE ONLY WIRE TIE.

FRANK B. COOK, CHICAGO.

Frank B. Cook has again demonstrated what energy and close attention to business will accomplish. Eight months ago he decided to once more embark in the manufacture of protective devices, distributing boards and cable terminals. He secured quarters at 240-244 West Lake street, Chicago, ordered machinery and started to make the necessary patterns and special tools. This consumed several months' time and he was not ready to accept any orders until about four months ago. Since that time he has accepted and filled orders or now has in work orders for a large amount of his apparatus.

Prominent among his orders are: Sixty-two cable terminals and protectors for the Kinloch Telephone Company of St. Louis; 295 pole top terminals for 18,000 tubular line fuses for the Home Telephone Company of Los Angeles, Cal.; 98 terminals and protectors for Home Telephone Company, Springfield, Mo.; 19,500 pairs of protectors with No. 4 main distributing boards from the Automatic Electric Company; 6,000 pairs of these for the Home Telephone Company, Dayton, Ohio; 8,000 pairs for the Fifth Avenue Exchange of the Illinois Telephone Company, Chicago, and 5,500 pairs for Citizens' Telephone Company, Grand Rapids, Mich.

The North Electric Company placed orders for distributing boards and protectors for exchanges at Wooster, Ohio; Eureka Springs, Ark.; Oneonta, N. Y.; Bellefontaine, Ohio, and two or three other points.

The Kellogg Switchboard and Supply Company ordered about 9,000 pairs of protectors, some 8,000 of which are for the Home Telephone Company, Los Angeles, Cal.

The Stromberg-Carlson Telephone Company have also placed large orders for No. 4 distributing boards and protectors, among the exchanges equipped being United Telephone and Telegraph Company, Chicago; Glen Telephone Company, Johnston, N. Y.; Park City Telephone Company, Bowling Green, Ky.; Utica Home Telephone Company, Utica, N. Y. Liberal Telephone Company, New Decatur, Ala.; Belmont Telephone Company, Martins Ferry, Ohio; Belmont Telephone Company, St. Clairville, Ohio; Belmont Telephone Company, Bridgeport, Ohio.

In addition to the above enumerated orders many smaller ones were also received requiring a total for all orders of 110,000 heat coils, 240,000 carbon arrester plates and 61,000 tubular line fuses.

ACME ELECTRIC COMPANY PHILOSOPHY.

A wise man never wants what he can't get.

Ill luck often turns friends into mere acquaintances.

Heaven never helps men who have that tired feeling.

Poverty may sidetrack a man, but it never blows him up.

A man's intentions go for naught if he stubs his toe in action.

Hope is all right when mixed with an equal amount of hustle.

Many a truthful man has been known to lie at the point of death.

The average man finds it much easier to pay compliments than debts.

The wife who talks the least has the best control over her husband.

Heat generates motion. If you don't believe it pick up a red hot poker.

That tired feeling is often due to a strenuous effort to live without work.

Happy is the man whose smile is the same in prosperity and adversity.

There is always one sure thing in betting, and that is your chance to lose.

Laughter answers the same purpose that fire does in a damp house, dispersing chills and making all bright and cheerful.

There is evidently electricity in a cornfield, becauses it produces shocks.

If a man is too lazy to begin he always says it is never too late to mend.

You never really know a man unless you allow yourself to owe him money.

Nature paints the country, but she leaves the job of town decorating to men.

Every man ought to have a good-natured wife to grumble at occasionally.

Slight no man because of his poverty and esteem no man because of his wealth.

Some people's idea of economy is to deprive themselves of things they don't want.

Fortunate is the man who learns a lesson from the experience of his neighbors.

A genius is a man who can make other men believe he knows more than they do.

Sometimes a man is judged by his appearance and sometimes by his disappearance.

Sometimes it is a man's dinner that disagrees with him and sometimes it is his wife.

When a man wants to make a fool of himself he usually gets some woman to help him.

A marriage license is a receipt in full for the promises a man makes during courtship.

A married man is apt to get mad if he finds out that his wife isn't worrying about him.

When some people attempt to display their knowledge they only show their ignorance.

It is human nature to desire to be equal to your superiors and superior to your equals.

Some people are like straws on a river; they do not go through the world, but are carried.

A man who says he enjoys a church social may not be a liar, but he is not above suspicion.

All the mean acts of his life are quickly brought before a drowning man or a candidate for office.

The individual who gets into the habit of giving way to depression is on the broad road to ruin.

Adam's troubles may have been due to the fact that he had no mother-in-law to hand him advice.

Most of the shadows that cross a man's pathway in life are caused by his standing in his own way.

Job's record for patience still remains unbroken, but then Job never backed up against a porous plaster.

The man who attempts to keep a joint bank account with his wife is apt to find it out of joint frequently.

The man who wants to prove everything he says advertises the fact that his word isn't to be credited.

A man seldom realizes how few of his remarks are worth repeating until he has conversed with a deaf person.

You can safely gamble your last ten spot on the man who works as hard for others as he would for himself.

A physician always asks a sick man what ails him, and then proceeds to charge him $2 for the information.

Young man, if you have a sister love and cherish her; but if you haven't, then borrow some other fellow's sister.

If a man is a chronic grumbler it always makes him happy to find a button off his coat when his wife is busy.

The Lord hasn't much use for the man who contributes to foreign missions the money he owes his washerwoman.

Eve complained that she had nothing to wear and her daughters have been working the same old plaint ever since.

There is no law to prevent a woman kissing a pug dog—but at the same time it's a mean advantage to take of the dog.

A Mississippi mob made a bonfire of a negro and the coroner's jury returned a verdict of "Overcome by the heat."

Much of man's trouble is due to the fact that when he takes a drink he insists on taking another to keep it company.

When you see a married man with his trousers nailed to his suspenders it's a sign that his wife belongs to a sewing society.

When a widow makes up her mind to marry again she selects the man and then proceeds to find out what he likes best to eat.

The average man regards his wife as an angel for two weeks—one week before marrying her and one week after her funeral.

The man who leaves church just as the collection plate starts around may have been taken suddenly ill, but he rarely gets credit for it.

NEW FIRE ALARM EQUIPMENT.

Among the latest announcements among manufacturers concerning new apparatus is that of the Illinois Electric Specialty Company of Chicago regarding the new fire alarm device it is now putting on the market.

It is a system for fire protection that requires no change in the switchboard or telephone equipment, but is simply bridged on the subscriber's circuit and the instant a fire starts the alarm is given locally and at the same time the operator is notified at central of the location of the fire.

The company instead of offering the goods through its agents to the general public is dealing through the telephone companies who are installing them and charging a monthly rental the same as for telephone service. The system costs very little to install and not to exceed seventy-five cents a year to maintain and its installation will add greatly to the revenues of any telephone company.

A BLOW TO LETTER WRITING.

One reason why the art of letter writing is dying out is that the telephone is being used more than ever as a means of communication between friends in the matter of invitations, for the announcement of important events and for the sending of messages of congratulation and condolence.

Those who cling to the old forms seem to be in the minority to-day. The younger generation refuses to be hampered by the time-consuming methods of several years ago, when a note of invitation, for instance, could not be sent through the mail, but must be delivered by hand.

The modern youth or maiden picks up the telephone and dispatches an invitation to luncheon or the matinee, and even for so serious a function as a dinner it is quite common now for a hostess to call up a friend at the last moment, frankly admitting the action that she only desires to fill some place that has been left vacant at the last moment.

In fact, there is a fad for telephoning messages of this sort nowadays. When it first gained entrance to residences the telephone was intended as a means of communication between a man's office and his home chiefly; then it began to be used for the ordering of cabs, for marketing, for hurrying up slow tradesmen, and the various uses connected with housekeeping.

By degrees friends began to make use of the quick method of communicating with each other, and it was so delightfully informal that it became a vogue.

The informality of the telephone method of communication is what appeals to the younger generation of society, says the Pittsburg Gazette. An invitation given or accepted or rejected in this way has not the importance attached to the old method of a note delivered by a messenger. This was a serious affair, and one pondered over the answer to send, the extent of the social obligation involved, and other matters.

But the message over the wire is different. One does not have time to study questions as to motives, dress, the people one is to meet or any other of the small problems that frequently arise on the reception of a formal invitation.

The telephone bidding reeks of the up-to-date. It simply states that the occasion is there waiting, and it calls for a quick decision. There is no reading between the lines and no time to ask why and wherefore. It lacks the chilling dignity and importance that sometimes lingers quite unintentionally about a note.

Mrs. Smith may call up Mr. Jones at his office at 5 and ask him to join a dinner party at 8, if he will be so good, and although Jones may know quite well that he is bidden to fill up, he appreciates the frankness of the message, and if he has no engagement he will accept in nine cases out of ten because the invitation is impromptu, and people speedily know that impromptu occasions are apt to be the most enjoyable.

At the same time he is quite free to decline if he wishes, and his declination will not have the weight of a written regret, for a written regret is nearly always chilling in its effect upon the recipient, no matter how carefully it may be worded.

As to the messages that pass between women relating to their shopping trips, luncheons, matinees, drives and visits, the wires are kept busy in the residential districts all day long. Soon after breakfast the calls begin, and they keep up until luncheon time, when the feminine world rests for a space, and enjoys its favorite meal of the day.

Deaths, births and marriages are now announced in this way, and congratulations and condolences are given over the wire. Nothing seems too serious for the telephone, and sweethearts even choose to bill and coo many times a day over the wire, as "Central" can testify.

JOINT TRANSMISSION.

In a paper read before the Electrical Society of Cornell University February 2, 1903, on the joint transmission of differing currents, Mr. Frederick Bedell says:

"This is an era of combination. The particular combination to which I invite your attention is a combination between the one-time rivals, direct and alternating currents. In fact the combination is far more reaching, for alternating currents of different frequencies may be combined, and so too may power transmission currents and currents for the transmission of intelligence. The same system of conductors may supply our alternating lamps and our direct current motor. We may remove an incandescent lamp, attach a telephone and talk over the incandescent circuit with our neighbor.

"An important characteristic of differing currents is their *non-interference.* Assigning personality to the currents, we may say that Current A when traversing a wire does not know that Current B is there, the two being of different character. Neither current recognizes the existence of the other, and is in no wise affected by its presence or absence. To illustrate the extreme to which this is true, we may refer to the experiment, which some of you have tried and others may try in the laboratory, of telephoning over a power circuit from which motors are operated. The starting and stopping of the motors does not affect the telephone."

The paper is quite a lengthy one but the foregoing paragraphs are the only ones referring to telephony.

P. C. Graff, general manager of the Richmond (Indiana) Home Telephone Company, died suddenly on Feb. 4.

Machine Telephone Operating

By JOSEPH B. BAKER

The recently reported death of Mr. A. B. Strowger, to whom were issued the earliest Strowger patents for making telephone connections by an automatic at central instead of by the hand of an operator, has suggested that a paper descriptive of automatic telephone operating as practiced to-day would be timely.

While electrical engineers and observers of the progress of applied electricity are accustomed to extremely rapid developments in this field, it is thought that there may be many, otherwise well informed, who need information upon the actual status of automatic telephony, in order that they may be prepared to understand the genuine revolution that is practically impending in methods of telephone operating. For, while the potential value of a machine to make telephone connections has been recognized, although at times grudgingly, by telephone men among those who are inclined to set the word "practice" over against the word "theory," up to a very recent date the actual apparatus that has been designed to replace human operators has met the most adverse criticism. Condemnation of the apparatus, of its working, of its right to existence under any conditions, has been a favorite topic among telephone men; and the same arguments and disparagements that were expressed upon the appearance of the first Strowger scheme have persisted beyond their legitimate life in the actual presence of the modern, workable, successful apparatus of to-day. In this connection one is reminded that, while conservatism is a good thing, it has its time limitations; and the present instance of a clinging to hand telephone operating and to the hope of a way out of the handling of the larger aggregations of telephones of the near future by further detail improvements of hand-operated manual switchboards can no longer avail, in the writer's opinion, to ward off a revolution in operating methods, only intensified by apparent delay in its consummation. The automatic telephone exchange for Berlin, the exchanges ordered for Dayton and Columbus, Ohio; Grand Rapids, Mich.; Portland, Me., and the greater plans for Chicago, are illustrations which will inform the general public quickly of the success of machine telephone operating. But the evidence they will provide will not be needed to convince the unprejudiced telephone engineer familiar with the continued successful working of smaller installations, such as those at Fall River and New Bedford, Mass., and aware of the proof they have given of the possibility of applying machine operating to larger exchanges than the largest existing manual boards.

In the beginning of the telephone service, manual operating was the natural method of connecting A's telephone with B's. It was most natural, too, that telephone engineers, whose work was specializing into the design or construction of larger and larger exchanges, should seek improvement by inventing and installing detail devices to assist the operator in putting up, supervising and taking down connections. "Hello, central!" was a phrase, one might say, that was at the basis of the growth of aggregations of apparatus —switchboards and operating systems—whereby it was sought, more or less successfully, to make a large exchange as flexible and quick-working as the primitive board having one section, one operator, no toll lines, and one flat rate for service. The early public of telephone users was a small and patient one, to which the telephone was a marvellous, new means of communication, quicker, more convenient, and more interesting than the sending of written messages. The improvements in manual operating, from the commencement of telephone service to the present day, have been an unbroken series of devices and groups of devices built around, and having reference to the human operator, sitting in front of her spring-jacks and plugs at central; each new system, comprising a switchboard, with sections sufficiently multiplied to cover the number of calls capable of being handled per operator by the system at time of estimated maximum demand, and equipped with new and improved devices whereby an increased number of manual movements might be made by the operator and so her average of calls handled might be maintained under pressure of the rush periods; and all efforts at improvement being for the purpose of compensating for the unwieldiness incident to the expansion of human labor as such by specializing and facilitating the labor. From the days of the grinding of a magneto-crank and "Hello, central!" to the most up-to-the-minute common-battery system, the operator's capabilities and their susceptibility to improvement have been studied; whether the handling of large exchanges has been sought to be accomplished by a multiple or a trunking switchboard and system, it has always been a matter of providing the operator's ear and pair of hands with improved electrical and mechanical devices whereby her brain and hands could accomplish the greatest amount of work in a given time. In meeting the conditions of rush periods by an adequate supply of trunks and cords; by positive and informing signals; by quick working, self-contained ringing and listening keys, etc.; by proper hours of labor and relief, and by an operating-room discipline dictated by experience with the conditions of the immediate past; by exactly adequate wage schedules and plans of rewards and penalties; by attention to everything pertaining to the operator as the user or operative of the multiplied and ingenious telephone-connecting apparatus placed at her disposal, down to the best machine for sharpening her lead pencils, the human brain and hands have been assisted, and brought to their work, and maintained in the best attainable adaptation to it. In other words, with the evolution of the switchboard consequent upon growth, the manual operator has been provided with newer and more efficient sets of tools with which to execute the crowded series of hand movements, accompanied by a minimum of verbal acknowledgments and replies, that constitute her work under rush conditions. A reduction of need for her attention by this phonograph circuit, a saving of a fraction of a second by that keyboard device, an increase of trunk efficiency by that other signal circuit, have made the enlargement of her effectiveness whereby the increasing strain of the rush periods of the telephone day could be met with the least possible increase of delay to the calls over the standard minimum delay in the service given by a one-operator, one-position board with a small number of calls to answer.

In a recent article upon the cost of telephone service in which its writer took occasion to express some outworn condemnations of machine telephone operating, the statement was made that the modern central energy exchange system, with its operators signalled for calling, supervision, and clearance by switchboard lamps controlled by the substation switchhooks, was in itself a machine; and as such was superior to any automatic, that is, operatorless, exchange system. While the time has gone by for the need or propriety of a defensive advocacy of automatic versus man-

ual operating, since the time is at hand for the evolution of machine operating to eventuate into a great revolution in telephony, it may serve the purpose of the present article to examine the statement above referred to, with a view to determining its truth or fallacy by a reasonable comparison of the conditions of telephone operating with other engineering propositions. The time has quite gone by, as it always must sooner or later, when new methods prove their coming right to the field by living and growing under opposition, for sweeping assertions to answer for solid arguments, or caustic deprecation of results attained to stand in the face of such results. The seal of approval that has lately been set upon machine telephone operating by such eminently practical bodies as the imperial German government and the financially weighty personnel of the Illinois Telephone and Telegraph Company of Chicago, now making an overwhelming invasion of that city with Strowger telephones, will go far toward placing the burden of any argument on manual versus automatic telephone operating upon the champions of the manual system.

The experience of industrial civilization has proved that in all departments of traffic or manufacture, machinery is not only of immense advantage over hand labor for the execution of mechanical movements when the volume of the latter increases, but is absolutely essential when the instance of traffic or manufacture is one supplying a general need. The possible application of a machine in a given instance, with its power of vastly multiplying the product of manual labor, is a matter of whether it can be shown that the movements concerned in the particular traffic are actually mechanical; that is, are designed movements following different respective other movements as causes all of which are known. It does not inhibit the use of a machine to have the causal movements occur in irregular order, or the consequent movements subject to combinations of causal movements or positions of the mechanism. The only condition necessary to be fulfilled to make the design of a successful machine to replace manual labor possible, is that all of the possible contingencies—that is, combinations, mechanically speaking—are known; in other words, the machine must not be called upon to think, in the sense of providing more than one consequent movement following a given causal movement or combination. No matter what the complexity or number of movements to be provided for, nor what the irregularity with which they come, with the stated condition fulfilled, a machine superior in time-efficiency to hand labor is possible; whether its invention is probable depends upon the universality of the need for its work in replacing human hands. When in the limit case of an instance of traffic or manufacture need, so general that hand labor, or hand labor that is only assisted by detail mechanical devices, means a cost excessive and burdensome in the presence of the need thus become a crying one, the complete machine is the inevitable complement result. To give an instance of this limit case, consider the production of a metropolitan newspaper—an illustration that lends itself well as a manufacture comparison to the instance of traffic under consideration. The community finds that to have the news is a necessity. To print the tens of thousands of papers needed to supply this general demand, in the few hours limiting the life of news, an ordinary power press, fed by hand, and machine-made type set by hand, cannot do the work; the case is one wherein the whole contract, so to speak, must be given to a set of machines handling the entire process of production from the wood-pulp to the folded newspaper. The use of manually executed movements, using it matters not how many pairs of hands, for any part of the progress of production would mean one or both of two things, either one crippling the general dissemination of news; the raising of the price of newspapers or the lowering of the number of copies issued per hour.

This concrete example of the essentiality of a complete machine in filling a general public need wherein success means a superhuman rate of production is not cited as a case mechanically parallel to the telephoning of a large community; but it is mentioned to show the essentiality of a machine, or set of machines with consecutive and conjoining functions and so without the handicap of manually executed movements in any essential part of the complete process, to a very high rate of production co-existing with the popular cost complementary thereto. It will now be sought to show that the best modern manually operated telephone switchboard is not a complete machine, but a machine merely assisting, and therefore handicapped by human labor, to the result, contrary to public policy, of both actual and relative increase of cost of service with increase of volume of traffic; and further, that the adoption of a complete machine for telephone operating, in the form of the actual Strowger automatic telephone exchange system, not only means a reduction of cost of service to the public with increase of traffic in harmony with public policy and broad industrial principles, but also constitutes the only and essential method, at this date, of giving service to larger aggregations of telephones than the largest present manually operated aggregations with no increase in operating delay over that of the typical standard of one operator, one position and few calls, and with an actual reduction in operating expense, as far as licensee company is concerned.

In the manual operating systems of the best modern type, the working of the calling telephone hook signals the operator, who, in a longer or shorter time dependent upon the presence or absence of rush conditions, answers by executing the three manual movements of selecting an unoccupied cord, plugging into the answering jack, and setting a key to listening position, and by the verbal question: "Number, Oxford," naming her exchange to inform the party calling of her identity as operator in his central office. Note that all of the element movements specified, during the execution of which the operator's attention is wholly monopolized, have brought the call—the new traffic increment—only as far as the stage of being about to begin, as far as the operating economy of the switchboard position is concerned. Still more striking and unmechanical is the aspect of affairs from the point of view of the party calling; for, with a simple phrase to utter necessary to start the machinery of getting his call, is actually obliged to wait, for a longer or a shorter time, with his whole attention tied up by this mechanical detail and pending the operator's ability to turn her whole attention his way. The movements of mechanism involved, from switch-hook to operator's listening key, have been individually quick, sharp, and efficient—assuming the best manual operating under non-rush conditions—but they do not avail to give genuine quickness on the whole operation to this stage because the comparatively long delays due to what I may call drag of mutual attention between party and operator, to dead loss of time in the verbal expression of an elementarily mechanical idea by party, and further long elapsed time in verbal repetition of same by operator, are in the aggregate absurdly great in comparison with the aggregate of the switchboard movements alone, made by the operator. In other words, there is no consistence, no team work or possibility of such, between the human entities thus co-operating under difficulties, and the laboriously improved and refined mechanical appliances they are handling. The process as described is all right for a few calls an hour in a small community; but it is an anachronism, an offense against the fitness of things, when one comes to consider the possibilities of the telephone under traffic conditions that need electric quickness for the whole proposition of this method of transmitting intelligence.

Such traffic conditions are those of the immediate future,

when, as the Chicago Strowger plan provides, there is a telephone in every business office of any commercial standing. Indeed, the burden of the traffic conditions of the present, in cities with large aggregations of telephones requiring quick inter-communication, is a trying one, that, were it not for the organization in the parent company whose competitors are called the opposition, whereby the largest exchange groups are supported under non-profitable conditions by the smaller and better-paying exchanges—would have brought the crisis in the telephoning of large cities to a head some time ago. The manual switchboard, with its elaboration and complexity growing by leaps and bounds in proportion of growth of subscribers' lists, becomes a formidable financial burden in spite of high city rates for telephones, measured service schedules, party lines, and the charging of all possible expense to construction rather than to operating. The real bugbear of very greatly increased cost of operating per telephone, with increase of number of telephones operated—inevitably inherent, as a broad matter of engineering experience, to any manual system—can be only apparently mitigated by measures of expediency; the very real problem of heavy traffic telephony grows in acuteness notwithstanding. It is an instance of the bolstering up of methods originally good but become out-worn under modern conditions; a history of a progressive series of problems hurrying along and presenting increasing difficulties met individually with great ingenuity and success, but standing only as partial victories in a lost cause when looking back from the present impending day of enormous telephone traffic, to the time, recent though it is, of merely large traffic. The enormous traffic of to-day and to-morrow and the merely large traffic of yesterday are two conditions that differ not only in degree but in kind, and fundamentally; that is the state of affairs that needs to be realized for a true conception of the inadequacy of hard labor in a traffic whose right to be machine-handled has been delayed at such cost, and whose entering upon that right means such a revolution.

An examination of the actual performance of the Strowger automatic system of telephone operating simplifies and reduces to the concrete all these considerations, by looking at the problem of high-traffic telephony from the right end. Imagine the city of Boston equipped with the Strowger automatic system with trunks between city exchanges and to suburban exchanges. Such a plant would cover the area of the present Metropolitan Boston district with a flat rate for communications whether from one's office to another across the street, or to one's suburban residence, say, in Newton, seven miles away. In the general statement this is comparable to the present telephoning of this metropolitan area; but under the automatic plan it would be advantageous to provide a greater number of small exchanges than is indicated for the manual, for the two-fold reason that trunk efficiency is so much higher in the former, and that, apart from the needs of executive offices in the way of space, light, air, and convenience in some one of the exchange locations, a number of comparatively small "lofts," only large enough to house the apparatus itself, is, so to speak, a much more flexible plan. The telephone book would contain a series of numbers, assigned to the subscribers in the metropolitan area without exchange designation, and containing no party-line numbers; a feature of the automatic being that an absolute secrecy of communication is maintained.

It is not the writer's intention to describe the mechanical or electrical details of the Strowger telephone and central office apparatus. Recent issues of the electrical press have graphically described and illustrated these details The intended scope of this article is rather to compare, in continuation of the above analysis of the starting of a manually-handled call, its practical working with that of the most modern manual exchange system. And at the very start it is to be borne in mind, for a clear appreciation of the revolutionizing extent of the improvements wrought by the introduction of the automatic, that the apparatus is durable, simple, mechanical and practical, judged by the best standards of telephone apparatus design; having gone through the most drastic simplifications that could be indicated through constant and expert effort to improve. Some color was lent to adverse criticisms on fundamental points when the Strowger apparatus was crude and undeveloped; but in the presence of the apparatus of to-day doing the work in small and medium-sized exchanges, and ready to bring its capabilities to bear in the solution of the hitherto insoluble problem of the operation of large exchanges with profit at popular rates, these specific condemnations need not be answered. The more dignified course in presenting the case for the automatic at the present date when its commercial success is assured, is the course suggested by the impending relative position of the automatic and manual systems of operating, respectively, the successful product of evolution, and the partial and inadequate stage in the handling of this communication traffic. It is the writer's purpose, therefore, to make a comparative analysis of operating details by a statement of what the telephone operating machine accomplishes in its contact with the plant of wires and telephones under heavy use of these, and of how the resulting efficiency reaches a point essential to the giving of service in large volume at correspondingly low rates and far beyond the possibility of attainment by the best trained effort of any practical group of human operators.

The calling-up process traced above in detail for the manual system is accomplished at an automatic telephone by rotating a numbered dial in as easy and practical a way as the pressing of a button. The dial mechanism is a part of the apparatus that has been especially simplified of late in the evolution of the Strowger system. The use of numbered finger-holes and a finger-stop, to limit the motion of rotation, makes the apparatus as practical as a fire alarm; while being familiar in use as to require actually less exercise of volition by party calling than the verbal utterance of the number. Further, the contacts made by the dial mechanism, and by which electrical impulses corresponding to the number of the finger-hole used in rotating the dial for the numeral of the number being called, are sent over the line, are made on the spring-driven return of the dial to its normal position, thus ensuring that the line impulses succeed each other at the uniform rate proper to the actuating of the central office automatic switch. When the successive numerals of the number called have been pulled down, the two telephones are connected; and it only remains for the party calling to press the button on his set to bring party called to the other end of the line that has been selected by the central office switch or twitches moving simultaneously with the return movements of the dial of the calling telephone. In case the party called is already busy, the office switches proceed to build up the connection as in the case of the good call just described, except that a busy signal is substituted for actual connection with party called, giving a buzzing on calling line which remains till party called hangs up on his existing connection. This detail operation comprises a positive lockout with busy test for a pair of telephones connected together, and an instantaneous clearance of both such telephones from lockout and busy test on the hang-up of the calling party of the two. The only delay following the pressing of the button at calling telephone is that of party called in answering his telephone, as the office switches move simultaneously with the calling telephone's dial movements. On hang-up of party calling, clearance of both lines is instantaneous with hook movement. Note the following comparisons with the manual system:

First. The party calling is his own operator in the sense that without need of special skill he has the same command of the telephone plant that a trained operator has

sitting at a manual board. Further than this, the co-operation of his calling dial mechanism with the central office switches means that his natural and easily-executed manipulation accomplishes with far greater speed and certainty the operations that belong of right to a machine, and of which the manual operator makes hard work, and very fallible work. The change from manual to automatic is the taking away from pairs of hands the handling of devices that are parts of a machine; and then the going of a step further by simplifying the parts with reference to their functions till the combination becomes a consistent machine from having been what is wholly different—a group of labor-saving mechanical devices operated by hand.

Second. The party calling gets what he is paying for and what he became a telephone subscriber in the hope of getting—a telephone service that is not only quick as a general thing, but is just as quick under the pressure of a sudden enormous increase in demand for connections. Here we come to the peculiar fitness, amounting to essentiality, of the Strowger automatic system to any conceivable hand system in the presence of large traffic per telephone. The condition becomes one that belongs to a machine and cannot be handled by manual labor without delay and friction, reacting on each other to cut down efficiency. Every manager of a large exchange is familiar with the daily recurring state of affairs known as a rush period marked by tangled cords, rattled operators, trunks and cords held up because used wastefully in response to the impatient demands of telephone users all coming at once and finding that at the very time they most need the recognition and execution of orders for service the central office is least able to co-operate. That the automatic is free from this confusion and lowering of efficiency is due to the fact that it is a machine; a real machine to which the whole operating proposition is given. It is a machine that cannot be confused nor crowded because it uses its component devices without wasted time, without overlapping of functions, without misunderstanding, without need either to acknowledge or repeat an order for service, and without a temperament to be demoralized. In the manual the apparatus is there—far more of it than a machine would have use for—but it is tied up to human labor and inadequate when it can only be used by a pair or pairs of hands. In the automatic the time otherwise consumed in acknowledging and repeating telephone numbers, the elapsed time on subscribers' lines, on cords, on trunks, during which telephone users and telephone operators are trying to get together and are making a cumulative failure of it, is all put into the general stock of precious seconds saved, by use of which the machine makes an easy success of the handling of so-called rush periods. When the party calling puts in his call, it is received at that instant, and by a machine which does not acknowledge or repeat it, but executes it; the act of calling, accomplished without need of first gaining another's mental attention, is consolidated with the completing of the connection, in point of time consumed. Further, the time elapsing between the ringing by party calling and answer by party called is wholly chargeable, and understood to be so by both parties, to delay of party called in answering his telephone. Lastly, when receiver is hung up, or hook is worked, the suscriber does not signal an operator to take down his connection or to answer him for a new connection; he clears out, the execution of this operation being consolidated in point of time with the act of completing his original call, and this function leaving his line ready for a new connection outward or inward as the case may be and without need or object in gaining another's mental attention.

The more one considers the natural comparisons that present themselves between the manual and the automatic, the more clear it becomes that the former, inevitably the first to be developd, must as inevitably give way to the latter as its logical evolution in the presence of the compelling conditions of modern telephony as a preferred means of informal intercommunication.

That the change from one to the other is being made at a rapidly accelerating rate is after all less to be wondered at, in this time and country of rapid and substantial appreciation of the effective application of machinery, than is the delay in the preparing of the change and its consequent transformation into an impending revolution in telephony.

GENERATORS.*

Generators are made to give out either alternating or direct current and the former is mostly used for telephone work.

The generator was first constructed in 1858 by Dr. Werner Siemen. Generators producing alternating current are used on series and bridging lines, a difference being made in the wiring of the armature. Our experience teaches us that generators used to operate a series ringer wound to eighty ohms should be wound for producing a high electromotive force as there is always a great amount of resistance to be overcome. We have found that a five bar generator of 50,000 ohms, series, should be wound with No. 35 silk covered magnet wire to a resistance of 550 ohms. Such a generator with proper mechanical construction and good permanent magnets has an output of ninety volts and .10 amperes, which is about equal to nine Watts.

It might be well to explain here what is meant by the terms 25,000 ohm or 50,000 ohm generator. It means that the generator will ring its own bell through the resistance specified. Generators for bridging systems should be designed for quantity of current rather than high pressure, as they have to supply current to apparatus arranged in multiple. The fact that in some instances a high voltage is needed must not be overlooked. On long iron grounded lines heavily loaded, sufficient current must be generated to ring all the bells in multiple and sufficient voltage to ring the bells at the farthest end of the line. The winding of a generator armature is therefore a question of vital importance and must vary to meet different requirements.

A bridging generator, five-bar magnets, 50,000 ohms, should have the armature wound to about 350 ohms with No. 33 silk magnet wire.

The output of a six-bar 100,000 ohm bridging generator is about 120 volts and .26 amperes, which equals about 31 2-10 Watts.

The three important points in the manufacture of a generator are high efficiency in workmanship, careful selection of magnet steel and magnetism. If the magnet steel is not of good quality, the core becomes demagnetized and is not susceptible to produce the variations of the primary current. Magnet steel is a certain grade of steel which experiments have shown to be best adapted for retaining its magnetism. It contains carbon sulphur, silicon, phosphorus and manganese. It is the proper proportions of these metalloids which makes it either good or bad. Iron having a very small amount of sulphur and phosphorus produce a high grade of steel. By carefully comparing the analyses of different steel it is possible to tell what the magnetic strength will be if properly hardened. A cherry red is the usual temperature to which steel is heated for hardening magnets. But this heat is modified according to the quality of steel or according to the amount of carbon it contains. A high carbon steel is least heated.

There are many recipes of hardening fluid for chilling steel. Mercury is the quickest, brine next, water next and rape seed oil next. The best results for magnet steel comes

*A paper read by Charles W. Farr before the Wisconsin Independent Telephone Association Feb. 11-12.

from cooling it in the quickest possible way. It is the presence of carbon and manganese which hardens it.

Horse shoe magnets can be magnetized much stronger than straight bar magnets as the poles are more closely together. The lines of force cluster between them. They have about four times the attractive power on a piece of soft iron near their poles than a bar magnet of the same size, and the best method of magnetizing is by means of a strong electro magnet furnished with a large pole piece. The steel is drawn over the pole always in the same direction twenty or thirty times.

CORRESPONDENCE DEPARTMENT.

Dear Editor:

Referring to the essay on "Profitable Telephone Rates" in a recent number please tell us what is included in item "General Expenses." See tables 2, 3, 4, 5, and especially table 8, pages 204 and 205.

Does maintenance in table 8 under percentages include deferred or contingent maintenance and fund to cover depreciation and eventual reconstruction, as well as the current daily and monthly maintenance expenditures?

ZENITH.

We are unable to say what the respective companies "included in the item General Expenses," as the financial statements on which the tables referred to are based do not go into these details. No two companies follow quite the same practice, and the smaller companies naturally omit many items included by the larger organizations. Following is a summary of the practice followed by several companies, each operating several exchanges and toll lines.

The items apportioned to general expense are classified under the following seven sub-headings: First—Salaries and Wages. This account includes the salaries of the president, vice-president, general manager, secretary and treasurer and of the office force employed in the offices of each of these officials. If an attorney is regularly employed his salary is included. The salaries of the engineer and of the electrician and of the division superintendent and their clerks are also included. Some companies pay no salary to the president and vice-president, and only a nominal salary to the secretary and treasurer, but pay a liberal salary to the general manager, thus insuring at least one competent and efficient official.

Second—Rent, Light and Heat. This includes the rent of all the offices occupied by the above-named officers and employes, and the cost of heating, lighting, cleaning and caring for same.

Third—Traveling. This includes the traveling expenses of the general officials and their assistants when engaged on company affairs of a general nature.

Fourth—Postage, Printing and Stationery. This includes the cost of account and record books, the various blank forms used, the printing, the stationery and the postage used in all departments of the company.

Fifth—Taxes. This includes all state, county and city taxes, including pole and wire tax and all taxes except those on real estate.

Sixth—Legal Expenses. If an attoriey is regularly employed his salary and expenses are treated as that of other officials. But the charges of attorneys employed for special cases appear under this sub-heading of Legal Expenses, as well as all expenses incurred in litigation, and also the compensation paid in settlement for personal injury, either by direction of the court or by compromise.

Seventh—Incidental. This includes items usually small in amount due to expenditures on behalf of or for the general offices, which cannot be classified under any of the foregoing six headings. The premiums on bonds required of the general officers are usually placed in this account; also office furniture, telephone periodicals and books, insurance on the office furniture, etc.

Now to reply to the second question. No, the maintenance in table 8 does not "include deferred or contingent maintenance and fund to cover depreciation and eventual reconstruction," but it is supposed to cover "the current daily and monthly maintenance expenditures." However, according to the statements of the presidents of several of the companies included in that presentation, it is doubtful if the monthly maintenance was fully covered. That is why many Independent companies are frankly telling the public that "we are not charging enough for our service" and that "the service costs us far more to produce than we receive for delivering it." In the past Independent companies flatly denied the possibility of depreciation in their brand-new plants. How was it possible for such pretty things to depreciate? Hence, why squander good money on such a useless luxury as deferred maintenance?

But the truths that Iowa and Wisconsin have been talking have shown many Independents the folly of continuing to deliver telephone service below cost and yet denying the existence of the very reasons that tend to make their investment a losing one.

This fact may appear clearer when we state that the average investment per subscriber in six Bell plants is $214.73, while the average gross earnings per subscriber on that investment is $54.86, or an average gross return of 26 per cent on that investment. Now the same number of Independent companies report an average investment per subscriber of $307.04, with a reported average gross earnings per subscriber of $24.42, or an average gross return of only 8 per cent on the investment. Ten other Independent companies report an average investment per subscriber of only $174.37, but the gross earnings per subscriber are only $15.10, or an annual average gross return on the investment of 9 per cent.

That is, on an average investment 43 per cent less than the six Independents claim, the Bell derives an average income per subscriber 102 per cent greater. And on an average investment 23 per cent greater than that reported by the ten Independent companies the Bell derives an income 263 per cent greater. This shows why the Bell is able to "include deferred or contingent maintenance and fund to cover depreciation and eventual reconstruction" in gross earnings, and also why the Independents fail to include it. But the Independents will include it before long—or make up the difference out of their own pockets. EDITOR.

NEW KANSAS COMPANY.

A new $3,000,000 company has been financed for the purpose of connecting all of the larger towns of Kansas by long-distance telephone. The company is called the Western Independent Telephone and Telegraph Company, and will have headquarters in Kansas City. The stock is pooled and can be had only by owners of Independent telephone lines, so it is said. About half of the stock has been sold.

Lines connecting Kansas City with Wichita, Newton, Ottawa, Emporia and towns west of those places with Abilene, Salina, Enterprise and towns west in part of the state, the mining towns of the south and southeast, with Leavenworth and Atchison, and, in fact, with all the large towns in the state, are either in construction now or are on the slate. The company expects to have a number of the lines in operation by the first of next July.

No man has any great concern in the telephone business who does not subscribe and pay for TELEPHONY. It is certainly a splendid magazine and deserves to prosper.—J. G. Cheney, Carrolton, Ga.